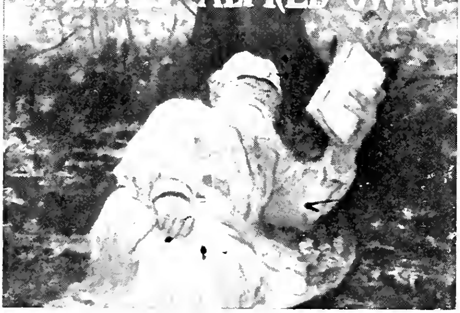

HYGIENE

DENTAL AND GENERAL

BY

CLAIR ELSMERE TURNER

ASSISTANT PROFESSOR OF BIOLOGY AND PUBLIC HEALTH IN THE MASSACHUSETTS INSTITUTE OF TECHNOLOGY; ASSISTANT PROFESSOR OF HYGIENE IN THE TUFTS COLLEGE MEDICAL AND DENTAL SCHOOLS

WITH CHAPTERS ON

DENTAL HYGIENE AND ORAL PROPHYLAXIS

BY WILLIAM RICE

DEAN, TUFTS COLLEGE DENTAL SCHOOL

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TO

MY MOTHER

This book is

Affectionately Dedicated

PREFACE

There are many reasons why the dentist should have an authentic and fundamental knowledge of hygiene. Whether willingly or unwillingly, he is placed in the position of an adviser. The ordinary practice of his profession is not alone concerned with the hygiene of the mouth. Troubles which he is endeavoring to prevent, correct and improve, affect the general health and are reacted upon by it. Moreover many people consult the dentist who do not visit a physician and to most of these he is a "doctor" who is expected to know not only the facts relating to infection, but also the rules for health. Many a practicing dentist can testify that he is questioned on every health problem from diet to municipal sanitation.

How much ought the dentist to know about these subjects? Obviously he should have the most definite knowledge available upon the interrelationship between abnormal conditions of the mouth and other organic and systemic defects. His knowledge of the danger of transmitting disease in dental practice should be equally definite. The rules of personal hygiene are of use to him not only in regulating his own living but also in getting the best results with his cases. To prescribe a schedule of hygienic living will often do as much as an office treatment in getting the patient into a normal condition.

Public health activities also have a right to claim the attention of the dentist. He is coming to take an increasingly larger part in municipal, school and industrial Hygiene and he should know the powers, organization and responsibility of the health agencies of the government. But apart from these fields in which he is interested professionally he has special duties of citizenship, for his training has given him a basis for appreciating the value of hygiene and sanitation. Excepting possibly the physician and sanitarian no one in the community can so well understand the possibilities and

advantages of efficient public health administration. The dentist may well be expected to assume some degree of leadership in these matters and if he is able to do so successfully his standing in the community is markedly benefited both socially and professionally.

There has hitherto been no treatment of the subject of hygiene specially prepared to meet the needs of the dental profession. In writing this book for the dental student and practitioner, special attention has been given to those phases of the subject which relate to dental practice wherever they occur.

In arranging the order of the text, those aspects of both dental and personal hygiene that are not related to infection are first considered. Then follows a discussion of the development of the new science of disease prevention and its effect upon dental practice, personal hygiene, and the public health.

The author desires to acknowledge gratefully the assistance received from many persons in the criticism of the manuscript. In particular thanks are due to Professor Percy G. Stiles of the Harvard Medical School for reading some of the manuscript on personal hygiene and for assisting in the preparation of a diagram of the autonomic nervous system. Special thanks are also due to Dr. F. H. Slack for reading the chapter on immunity, to Dr. F. A. Woods for suggestions in connection with the material on heredity, to Dr. A. LeRoy Johnson for assistance in the chapter on oral hygiene, and to other teaching associates for stimulating and helpful suggestions.

The author also wishes to express appreciation to Professor C.-E. A. Winslow for permission to use cuts number 6, 9, 10, 29 and 31 from *Healthy Living*, to Dr. Lawrence Baker for permission to use cuts number 3 and 4 from one of his unpublished researches, and to the many others who have assisted in securing illustrative material.

C. E. Turner.

Massachusetts Institute of Technology,
Cambridge, Mass.

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FOREWORD

By William T. Sedgwick, Sc.D.

Professor of Biology and Public Health, Massachusetts Institute of Technology, Chairman Harvard-Technology School of Public Health, etc.

Whoever regards the human mechanism objectively cannot fail to be struck with the growth and function of its harder parts. Bones, nails and teeth, though wanting in the early embryo, are rapidly formed soon after independent life begins. The bones, securely covered, are rarely exposed to decay or wear, and the skeleton in age is in many respects more complete and perfect than in youth. But with the teeth it is otherwise. Pushing outwards through the soft parts these are very early exposed to unfavorable conditions and, like knives and millstones, become dull and worn with use. Eventually, if not forcibly removed they fall out, so that at the end of life man is often "*sans* teeth," though not "*sans* everything"—no other organs of the body except the hair and epidermis being thus deciduous.

Hence it is that the teeth for their protection require unusual care—a fact now generally recognized by the rise of the dental profession and the popular enthronement of the toothbrush. But scientific care of any of the organs of the body is neither more nor less than hygiene, so that *Dental Hygiene*—the scientific care of the teeth—is one of the fundamentals of all hygiene. And since the human body is not merely an assembly of discontinuous and unrelated parts, but rather a complete entity or organism—originally homogeneous and never more than incompletely differentiated—so much so that the hand cannot say to the foot, or the brain to the teeth, "I have no need of thee"—it follows that dental hygiene is

only a part of *General Hygiene.* Accordingly, while this book deals with the hygiene of the teeth and takes its beginnings with the teeth it does not—because it cannot—end there. Foods and feeding, the flow of saliva, the blood stream and the lymph drains and, more remotely but not less surely, sleep and rest, work and play, muscular activity and mental fatigue—all these and many more aspects of general hygiene contribute to the welfare of the teeth. Conversely, the health or disease of the teeth plays an all-important part in the welfare of the other organs of the body and of the body as a whole, as all know who have been incapacitated by acute toothache.

Professor Turner's is the first work which, taking for its principal field the hygiene of a single set of organs, reaches out from these to the rest of the body. And perhaps it is for this reason that our textbooks of hygiene have so often hitherto been comparatively uninteresting and ineffective. It may be that they have been too general and in seeking to tell all things about hygiene have failed to tell any well. It is for this reason among many that I predict for this work an unusually hearty welcome, for those who read it attentively will find that while the text of the sermon is dental hygiene, and while the teeth—as in the speaking human face—are always near and much in evidence, the lessons taught apply quite as well to the entire human body and its effective conservation. Such conservation, however, not only requires careful consideration of the human body but of that environment with which the body deals and which plays upon it from birth to death.

Fifty years ago the slogan for health was *mens sana in corpore sano*—an admirable aphorism but one curiously typical of a neglect of environment characteristic of the pre-Darwinian period. Nowadays we know only too well that the sound mind and the sound body are unavailing for the conduct of normal living unless the environment with which

they have to deal consists of fairly good air, fairly pure water, fairly good food, and is fairly free from communicable diseases, unfavorable temperatures, defective ventilation, dirt, noise and other prejudicial sanitary conditions. Hence, Professor Turner surveying the whole field of dental and general hygiene has found it necessary to reach out beyond the teeth and other organs of the body, and even beyond the body itself, to a consideration of those environmental factors which contribute so heavily to health or disease, with the result that his work is not merely novel and comprehensive, but also original, logical and representative of the best hygienic thought of the time.

HYGIENE: DENTAL AND GENERAL

CHAPTER I

DENTAL HYGIENE

Hygiene or the science of healthful living furnishes to man the basis for a rational control over those habits and conditions of existence which affect for good or ill the smooth and normal operation of the body mechanism. The development of healthful habits of life depends primarily upon the individual, but the maintenance of healthful living conditions is largely beyond individual control, and the responsibility rests upon organized society. In the restricted sense hygiene considers the health of the individual, sanitation the control of the environment.

In considering the hygiene of both the mouth and the body as a whole there are two distinct sets of problems: (1) the proper development and normal functioning of the parts and (2) the problems arising because of infectious organisms. In this book the two subjects are separated, the first-mentioned receiving consideration in the first five chapters.

The Divisions of Personal Hygiene.—Personal Hygiene as contrasted with public hygiene or public health considers those principles and activities for the promotion of health over which the individual has control, and to determine the scope of this science we have to consider the functions of man as an animal. In blunt and simple language nature has decreed that man shall eat, work, think, and breed. The zoologist expresses this idea more elegantly and scientifically by saying that the particular functions of animals are assimilation, action, sensation, and reproduction. Accepting either set of terms in their broad sense we may group the problems of Personal Hygiene under these four heads:

1. Hygiene of Nutrition.
2. Hygiene of Action.
3. Hygiene of the Central Nervous System.
4. Hygiene of Reproduction.

HYGIENE OF THE MOUTH

The subject of Hygiene concerns the health of the body in all its parts and there is no natural division which makes it necessary to consider any particular portion of the body under a separate head; nevertheless Dentistry is such a distinct and highly specialized subject that it will certainly be profitable to treat the hygiene of the mouth in detail and apart from the above mentioned divisions, for the dentist's interest is of necessity centered upon oral conditions and, for this reason, he should be able to speak with authority upon the means available for the preservation of the health of the various oral structures and of the relationship of oral health to the general well-being of the entire organism. We are perhaps warranted therefore in adding another division of the subject for the purposes of this volume, namely the *Hygiene of the Mouth.*

In the treatment of this subject it seems desirable to consider it under two heads: (1) Proper development and normal functions of the oral structures (Chapter I), and (2) The treatment and prevention of unhygienic or septic conditions (Chapter VIII).

We will consider the means provided by nature for the maintenance of oral health under four headings, as follows:

1. Form and arrangement of the teeth.
2. Structure.
3. Investing tissues.
4. Saliva.

1. The Form and Arrangement of the Teeth should be such that their relationship offers the highest degree of correlation; each tooth performs its functions as a dependent unit

in a perfect machine operated under the motive power of the muscles of mastication.

A study of normal conditions is necessary and a conception of the normal should be constantly held in mind as a definite picture. The question may well be asked: What is the normal? Does it ever exist in fact? Johnson defines normal as applied to morphology as signifying "a standard determined by constancy."

The teeth are in four classes, incisors, cuspids, bicuspids and molars, each class designed for a particular function in the process of mastication. The type or form of the teeth in each of these classes varies according to the shape of the face of the individual, as Williams has shown in his classic work. ("Classification of Human Tooth Forms," *Journal of the Allied Dental Societies,* Vol. IX, No. 1.)

Contact and Occlusion.—When the teeth are in normal alignment the approximating surfaces of the teeth in each jaw are in actual contact at one point, known as the contact point. The object of this contact is the protection of the investing tissues. This is accomplished by preventing the crowding of food into the interproximal spaces. Any deviation from normal alignment or the loss of any tooth in the arch, (with the possible exception of the third molar) will result in impairment of function and a loss of the protection to the investing tissues; and opportunity will be afforded for the crowding of food material between the teeth, thereby establishing a condition favorable to fermentation and putrefactive changes.

The alveolar process, which is the bony tissue surrounding the roots of the teeth, is a temporary structure designed to furnish support to the teeth while present within the jaw. It is built up around the roots of the teeth as they develop after the eruption of their crowns and is removed by the process of absorption after the loss of any tooth. It follows, therefore, that after the premature loss of a tooth and the removal of its supporting process, no stimulus remains for bone devel-

opment; the continuity of the entire arch is broken and the teeth tend to drift in the direction of least resistance. This results inevitably in the loss of the normal relationship between the approximating surfaces of the teeth of each jaw as well as the occlusal relationships of the teeth in opposing jaws. Serious deformity may follow.

Smith has shown (*Journal of the Allied Dental Societies,* Vol. I, April, 1906) that in certain cases of malocclusion the timely and well judged extraction of teeth may result beneficially by relieving the crowded condition. The tendency of the drift may then bring the surfaces of the remaining teeth into positions closely simulating the normal.

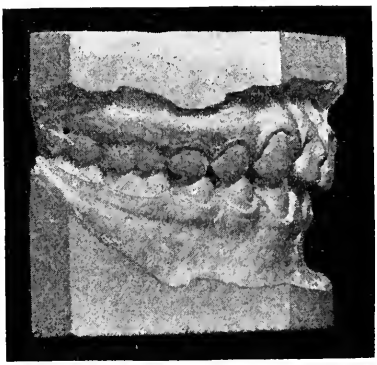


Fig. 1.—Model illustrating normal occlusion.

Orthodontia.—We agree with Johnson that the attainment of the ideal normal occlusion of the teeth by orthodontic interference is not always possible and in many cases an attempt to bring this about will result in an inharmony in the relationship of the teeth to the general contour of the bony and muscular structures of the face which nature will not tolerate. Not only will it be impossible to retain the teeth in their new position, which is an abnormal one, but there may ultimately result a deformity more objectionable than the original condition. Extensive orthodontic treatment

should be undertaken only after a careful study of all prevailing conditions by one whose vision is not limited to the teeth alone. It is futile to attempt to permanently establish ideal normal occlusion when all the forces of nature are being exerted to maintain the position of the teeth in their relationship to the organism as a whole.

Development.—Let us revert to the period of development. Baker has shown in his researches upon animals that the normal development of the dental arches is dependent upon the presence within the jaw of the developing teeth. The development of the bone is synchronal with the development of the roots of the teeth. The removal of the teeth from one side of the jaw was shown to cause an arrested development of the bone which resulted in marked deformity. The inharmony of the side of the face from which the teeth were removed was very apparent. It was further demonstrated

Fig. 2.—Model illustrating normal occlusion.

that normal development of the entire bony structure of the head is to a certain extent dependent upon the proper development of the teeth.

Function.—Among the causes of malocclusion must be considered the dependence of development upon function. For instance, a study of the organs of mastication of the anthropoid ape (man's prototype) reveals massive structure, demanded by the functional activity incident to the mastication of the kind of food available for his sustenance and upon which his existence depended.

With the development of modern methods for refining the raw materials to be used as food and the acquirement of the epicurean habit—which demands the preparation of complex, highly seasoned food calculated to stimulate pleasurable sen-

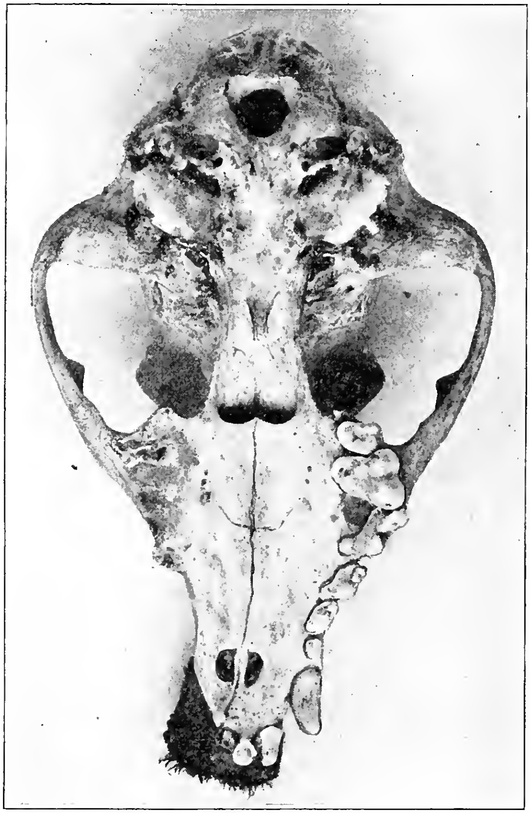


Fig. 3.—Observe the asymmetric development of the bones of the skull of a dog due to the interference with the function of the upper left lateral half of the dental apparatus.

sations in those whose appetites are already satiated by over-indulgence—the necessity for vigorous muscular effort has been removed and the stimulating effect of vigorous functioning has been lost. The lower part of the face has thus been

reduced in size but the teeth have not relatively changed. The result is that the teeth of many people are out of harmony in size with the rest of the features.

All variations from the normal in the development of the

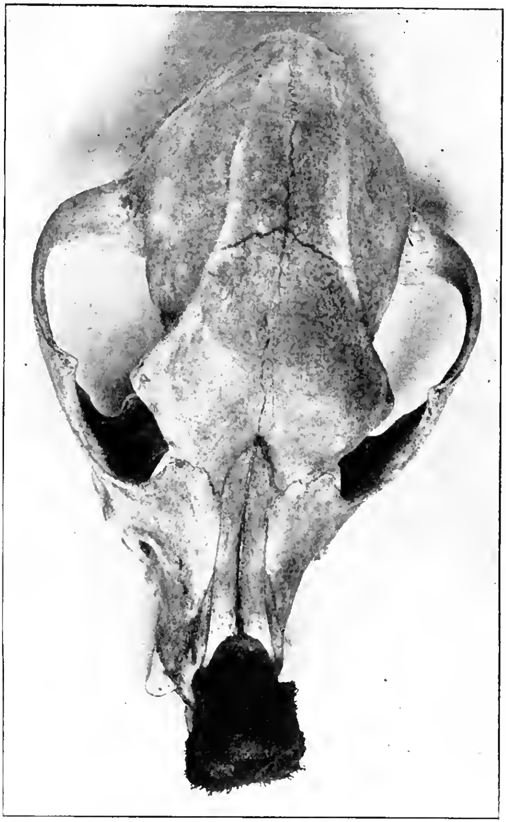


Fig. 4.—Upper aspect of the skull shown in Fig. 3.

various units, which are interdependent, must of necessity affect the proper functioning of the organism as a whole and, therefore, become problems in hygiene.

Although there is a difference of opinion on this subject,

there are orthodontists who believe that the normal development of the oral structures is also impeded by substituting the artificial feeding of the infant in the place of breast feeding. Whoever has observed carefully the infant in the act of nursing must have noticed that much exertion is put forth in the effort to obtain the milk. It is upon this muscular effort, and the enforced position of the oral structures during the act of sucking and swallowing that normal development is in a considerable degree dependent. No bottle feeding device perfectly simulates the breast or affords the

Fig. 5.—Deformity from lack of function. Ankylosis prevented the movement of the jaw.

vital muscular resistance which supplies the essential stimulus for the development of the oral structures of the growing infant.

Deforming Habits.—Deformities of the face and jaws arising from mouth breathing or other habits contracted in infancy, such as thumb-sucking and the continued use of pacifying devices, deserve consideration.

One of the most common causes of mouth breathing is the presence of *adenoids* in the posterior nares which so fill up the space required for normal breathing that the child resorts

to mouth breathing in order to obtain sufficient air. Adenoids are enlarged lymphoid follicles. These follicles are normally present in the nasopharynx but from various sources of irritation they frequently become congested and swollen.

The deformities resulting from the use of *pacifying devices* are frequently seen; and their use either reflects upon the intelligence of the parents or they are used in utter disregard

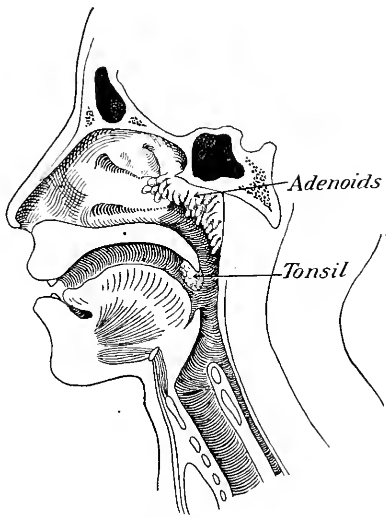


Fig. 6.—The air passages of the mouth and nose showing their relationship to the adenoids and tonsils.

of the welfare of the child. In any case the resulting deformity is a constant rebuke to the neglect of the child.

The thumb-sucking habit may be overcome by binding the arms of the child to its side or by the use of celluloid hand protectors. The deformity of drawn-in arches which results from thumb-sucking is so characteristic as to be unmistakable, and not only interferes with the functioning of the teeth but destroys the entire contour of the mouth.

2. Structure of the Teeth.—Nature has protected the teeth by furnishing for their outer covering the hardest sub-

stance to be found in the body. A difference in opinion exists in regard to the question of variation in the hardness of the teeth in different individuals and at different age periods of the same individual. To state the question more explicitly: are some teeth hard and others soft? Is this hardness or softness of the teeth subject to changes at different periods in life, and does nutritional action affect the integrity of the enamel rendering it more susceptible to the inroads of caries? Or is this lesion dependent alone upon the oral secretions

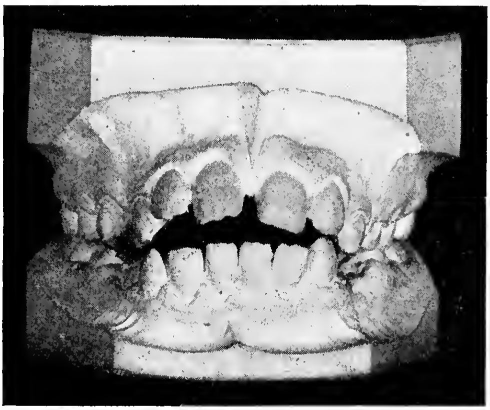


Fig. 7.—Deformity due to thumb sucking.

which are really determined by systemic conditions? A statement of the conclusions of recognized investigators may aid in forming an opinion.

Williams has stated that "enamel is a solid mineral substance and the finest lenses reveal not the slightest difference between enamel ground moist from a living tooth and that which has lain in the earth for hundreds of centuries." This statement would not seem to be borne out by analyses of enamel, for according to statistics published from time to time, the amount of organic matter varies from two to seven per cent.

Pickerell found that enamel is not impermeable and that stain penetrates to a varying depth in different teeth; moreover, the permeability varies in ratio to the length of time a tooth has been erupted. This would seem to prove that enamel does change its character after the eruption of the teeth. He also found that the density or compaction of enamel was in direct ratio to the time elapsed since its formation. The hardness of enamel was tested by determining the comparative resistance to scratching. The result of his experiment seems to be conclusive that there does exist a decided difference in the hardness of teeth. The hard teeth he terms *sclerotic,* and the soft teeth *malacotic.* He believes that the permeability, density and hardness are important factors in the predisposition to caries since malacotic teeth would more readily permit the penetration of the oral fluids.

Black made a series of studies published in the *Dental Cosmos* in 1895 relative to the hardness of teeth as a whole. His experiments bear special reference to the percentage of calcium salts in *dentin,* and as the initial lesion in caries always takes place in the enamel his conclusions would not seem to have a direct bearing on the susceptibility of teeth to caries. It may well be that the dentin of teeth is practically uniform in the calcium content.

Black asserts that the seeming differences in the hardness of teeth as reflected by their varied resistance to cutting instruments is due to (1) the direction of approach, (2) to the difference in the relation of the enamel rods to each other. Since enamel is not a homogeneous structure, but composed of hexagonal rods, held together by a cementing substance less strong than the rods, it is possible to cleave them along the line of their length more easily than in other directions. When the rods lie parallel with each other the enamel splits easily; on the other hand, in many teeth the enamel rods do not run parallel but are curled, twisted and interwoven. This enamel would cut with much greater difficulty even if there were no difference in amount of calcium salts contained.

Howe in his experiments upon animals has actually produced caries by depriving them of their natural food, such as green vegetables, milk and other substances rich in mineral content. Whether caries was caused by degeneration of the tooth structure due to lowered nutrition or whether the nutritional disturbance influenced the environment (oral secretions) is a question.

From a clinical standpoint I feel sure that a consensus of opinion would be that the character of the hard tissues of the teeth does vary at different periods in life, and the physical characteristics of the teeth are affected by the general physical condition of the individual. Whether this change comes from nutritive disturbances which in some unknown way affect the integrity of the tooth structure through the blood stream, or whether the changes are solely the result of influences from without is yet to be decided.

3. The Investing Tissues.—The teeth are set in the alveolar process which, as has been stated, is developed simultaneously with the roots of the teeth, gradually disappearing when its function as a supporting structure ceases to exist. It is the framework upon which the soft investing tissues are laid and in it are the sockets in which the roots of the teeth are set and held by their membrane. It envelops the roots of the teeth and develops in such a way as to rise to a considerable height between the teeth, forming a crest known as the alveolar crest.

The peridental membrane is the term applied to the soft tissues lying between the root of the tooth and the walls of the alveolar socket, its function being to attach the teeth to the bone of the jaw. Various groups of fibers radiate from the peridental membrane to the gingivæ and the alveolar process in which they are attached. These fibers not only attach the tooth to the alveolar bone but they pass from tooth to tooth over the alveolar crest forming a continuous chain connecting the teeth from one extremity of the arch to the other. These

fibers have the effect of a ligament binding the roots of the teeth to the bone. It will be seen that the extraction of any tooth literally breaks the continuity of the entire arch.

The **gingiva**, resting on the crest of the alveolar process

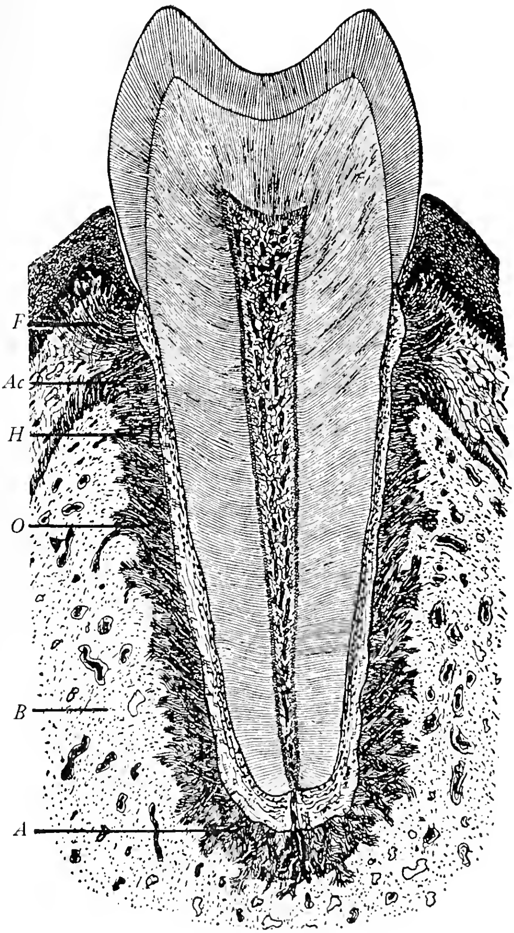


Fig. 8.—Diagram illustrating groups of fibers of the gingivæ and peridental membrane. Bucco-lingual section through a bicuspid tooth and investing tissue. *F*, Free gingivæ group of fibers; *Ac*, Alveolar crest group of fibers; *H*, Horizontal group of fibers; *O*, Oblique group of fibers; *A*, Apical group of fibers; *B*, Bone or alveolar process. (Black's "Special Dental Pathology.")

encircles each tooth and rises on the septal crest to a point below and near the contact of the proximal surface of the adjoining teeth. This tissue hugs closely the neck of the tooth but is not attached to it, the space between the tooth and the tissue being known as the sub-gingival space. Any injury to this free gingival tissue affects seriously its protective function and exposes a vulnerable portion of the tooth to the acid-forming bacteria, while the crowding down of the septal gingiva affords a favorable place for the impaction of food material. This condition frequently leads to the formation of a pocket which, becoming infected, gradually destroys the supporting structure of the teeth, causing their loosening and eventual loss.

4. The Saliva.—The role played by the saliva is also a very important one among the defensive or protective agencies, and its presence and constant renewal tends to maintain the normal environment of the teeth and to overcome by its neutralizing effect the harmful action of fermentation. In general terms it may be stated that the saliva is composed of water, albumen, mucus, ptyalin and the salts of potassium and sodium held in solution. The proportions vary in different individuals and in the same individual at different periods of the day. The amount of its different components will be affected by the physical condition of the individual and by the kind of stimulation inciting its flow.

Cannon has shown in his experiments on animals that the digestive fluids are greatly influenced both in amount and composition by the mental state of the animal. The mental impression produced by the sight or odor of food also has a similar effect. The old saying that a certain food makes the mouth water has its basis in fact. The mere thought of savory food or acid fruits is sufficient to stimulate the glands to increased functioning.

Saliva varies also in its physical characteristics from a thick, viscid, mucilaginous substance rich in albumen and mucus to a thin watery fluid containing small quantities of

colloid material. Carbon dioxide is always present in the saliva as in the blood and other body fluids.

The action of the *ptyalin* content is to convert starch into sugar during the process of mastication. Thorough mastication is essential to obtain the full effect. The sense of taste will quickly detect the change taking place, the sweet taste increasing as the chemical action proceeds. According to Black the ptyalin has a still further function in freeing the surfaces of the teeth and the embrasures of the clinging particles of starchy foods which remain after the mass has been swallowed. Pickerell also suggests that the principal function of the saliva is the hydrolysis of the starches.

The function of *mucus* in the saliva is largely a mechanical one. It lubricates and makes slippery all the surfaces of the tissues. It coats the teeth and imparts to their surfaces a smoothness and softness not otherwise obtainable. During mastication it mixes with the food and prevents it from sticking to the surfaces of the teeth, gums and mucous membrane of the mouth. It aids in forming the bolus of food which makes easy the act of swallowing. A deficiency in the amount of mucus will be evidenced by difficulty in the management of food in the process of mastication.

The *water* of the saliva acts by its presence, bathing the surfaces of the teeth, this action being promoted by the movement of the muscles of the cheeks and tongue, by which it may be forced through the interproximal spaces or drawn through by the action of suction. The habitual use of this function as a regular exercise in performing the toilet of the teeth may be of marked benefit.

Thorough mastication also influences not only the quantity and quality but the composition of the saliva. The alkalinity of the saliva is dependent upon its ash content and with an increased flow brought about by the stimulating influence of the exercise of mastication the ash content is increased and consequently the alkalinity proportionately raised. It has been shown by Pawlow that glandular secretions have the

property of adaptation; in other words the degree of alkalinity is largely influenced by the character of the food to be acted upon. In periods of physiologic rest the saliva is weakly alkaline and the quantity secreted is only about 1 c.c. per minute, this amount being greatly increased during the period of active functioning, the increase depending largely upon the nature of the food material. It is interesting to note that in cases of dry mouth the teeth quickly crumble away. A marked increase in caries is usually noted in any pathological disturbance of glandular activity. Prinz states that "the quality of the secreted saliva is the sole factor which governs environmental phenomena concerning tooth decay."

CHAPTER II

THE HYGIENE OF NUTRITION

The process of keeping the body in a properly nourished condition is complex. It demands the consumption of suitable foods in proper quantities, adequate digestion, the transmission of these digested foods to the parts of the body where they are finally used, the burning of the fuel foods, the rebuilding or growth of the tissue, and the elimination of the waste products of cell activity. The Hygiene of Nutrition may be divided into the problems of (1) diet, (2) digestion, and (3) assimilation.

1. DIET

Many people worry about how to get the foods they like, but few think much about choosing the foods which the body demands. Indeed if one led an active and normal life and could choose freely among the foods he likes he could, to a large extent, rely upon his natural taste to select the proper diet. To select a diet scientifically or to know where the unscientific method breaks down, however, we must understand the nutritional needs of the body.

These dietary needs may best be understood by studying the products of digestion which finally pass through the walls of the stomach and intestines. Were you able to accomplish the gastronomic feat of sampling every product exhibited at a food fair, there would be from all this food but six types of digestive products finally reaching the body tissue. To explain: if we regard the body as a tube within a tube, as we properly may, then the material in the digestive tract is not in the body proper; it is merely in contact with the "inner skin" and may only reach the body by penetrating the intestinal wall. Such penetration is accomplished by only six kinds

of substances: (1) water, (2) amino acids, (3) simple sugars, (4) products of fat digestion, (5) inorganic salts, and (6) vitamines. What is the use of each of these food materials in the body? Why and how must we provide a diet which will insure the proper amount of each?

Water makes up two-thirds of the body weight and in active tissues like muscle it is three-fourths the total weight. Moreover, the body has a liquid carrier system. The blood and lymph, which are mainly water, carry food to the tissues and remove from them the waste products of combustion. The chief way of eliminating waste nitrogen from the body is by means of the water passing through the kidneys. Every individual knows that in making thirst more painful than hunger nature has set a very high demand upon the water diet.

So important is the activity of water that we might almost speak of a distinct water circulation consisting of the passage of water from the diet into the body and its elimination from the lungs in the form of moisture, from the skin in the form of sweat, and through the kidneys in the form of urine. The amount of water excreted in these ways by an active man in the course of a day amounts to over two quarts. Yet in spite of these facts a deficiency of water in the diet, especially among people engaged in a sedentary occupation, is a most common and serious fault.

Water may be obtained in the diet in a variety of ways. The greatest quantity of course, is obtained through drinking water and other beverages, like tea and coffee, but much also is obtained from the solid food. This is notably the case with fruits and vegetables many of which contain over 90 per cent of water. Watermelon is 98 per cent water. Soup and broth are also sources of water supply in the diet. The amount of water necessary for proper waste elimination and for feeding the tissues in an individual of average weight is four or five pints per day. Of this, at least six glasses should be drunk in the form of water itself.

Nitrogenous Foods.—The chemically simple products of protein digestion are the amino acids. They are the substances from which new tissue is built up in the growing body, and from which worn-out tissue is replaced in the adult. These compounds are sometimes called the building stones of tissue substance because they recombine on the other side of the intestinal wall and in the various parts of the body to form the typical body proteins. These substances, chemically of simple molecule, contain carbon as well as nitrogen and may therefore undergo partial oxidation. They are to a certain extent fuel foods, since part of the molecule is oxidized to supply heat and energy. The chemical formula of one of the simplest amino acids, glycocoll, is CH_2NH_2COOH. Other amino acids are of larger molecule.

The protein foods in most common use are meat, fish, milk and eggs, although much nitrogen is to be found in the lentils, peas and beans, and in such wheat products as bread, and macaroni. Enough of this type of food is required to supply nourishment for growing or wasted tissue but it has usually been found that where man is free to choose his diet to a considerable extent there is an excess rather than a deficiency of protein. Only in India has a characteristic protein deficiency been found and here the effects among the members of the lower classes, where meat and fish are rare articles of diet, include a lessened physical vitality and a dwarfed stature. Where protein is taken in excess the carbon and hydrogen portion is used as fuel food and the excess of nitrogen is excreted through the kidneys in the form of urea. The office and professional worker often places a heavy burden on the kidneys by making them excrete a large amount of nitrogen in only a small amount of water.

Carbohydrates.—The carbohydrates (sugars and starches) are compounds of carbon, hydrogen and oxygen in which hydrogen and oxygen are present in the same ratio as in water. They are admirable fuel or energy producing foods because when they are oxidized or burned in the body they are

completely broken down into carbon dioxide and water, both of which are easily eliminated waste products.

Digestion reduces all sugars and starches to simple sugars of the $C_6H_{12}O_6$ type such as dextrose (glucose or grape sugar) and these are the digestive products which pass through the walls of the alimentary canal. The absorption of sugars is rapid and begins in the stomach. For this reason simple sugars supply the body with fuel very promptly. This also explains why eating sweets a short time before meals takes away the appetite.

Sugar is the form in which carbohydrate is transported and used in the body while starch is the more complex storage form. The blood usually contains from 0.06 to 0.1 per cent sugar and a reserve supply is kept in the liver as glycogen or animal starch. The body is free to draw upon this reserve when more energy is needed so that the amount of sugar in the blood may be increased when fear, anger or other emotions press the body for vigorous action. After the sugar content of the blood rises to 0.2 or 0.3 per cent glycosuria (the presence of sugar in urine) appears. For a man doing physical work especially in the cold where heat is lost rapidly a large carbohydrate diet is essential and under these conditions it is natural for the individual to increase the relative amount of carbohydrates in the diet. A man in a sedentary occupation does not require so large a quantity of this type of food.

Fats.—The third type of food passes the walls of the alimentary canal in the form of soap, glycerine, and fatty acids. The fats or hydrocarbons also contain the elements of carbon, hydrogen, and oxygen but the proportion of oxygen is less than in sugars and starches. Consequently they may be regarded as fuel foods in a more concentrated form since the same weight requires more oxygen for combustion and therefore is of greater heat value. Fat is a good reserve food since large quantities may be stored in the adipose tissues. To a large extent it is interchangeable in the diet with sugars

and starches. The production of large quantities of butter fat by the cow, which subsists upon a protein and carbohydrate diet, is an excellent demonstration of the ability of the animal body to synthesize fats from these other types of food.

Inorganic Salts.—The fourth group of body foods contains inorganic salts of sodium, calcium, potassium, sulphur, iron, and phosphorus. The salts of calcium are important in forming the hard structure of bone and the dentin of the teeth. The chlorine of common salt is used in the production of hydrochloric acid for gastric digestion. Iron, sulphur, and phosphorus are important constituents of the more vital tissues.

These salts are obtained in organic or inorganic form but are most readily usable in the body when secured as organic salts from plant and animal structures. There is at present a tendency among physicians to prescribe the salts needed by the body in the organic form in which they are found in foods rather than in the inorganic form as they are frequently combined in drugs. Most proteins are found associated with some of these minerals. Lettuce is particularly rich in potassium. Calcium is very abundant in milk. Phosphorus is plentiful in meats and egg yolk. With the exception of iron the salts in milk (as found in the ash) correspond not with those in the blood but with the ash obtained from the whole young animal. Iron is very plentiful in meat, yolk of egg and in spinach, apples and asparagus.

Vitamines.—The so-called vitamines, which have been classified here as the sixth group of food substances, are of a chemical composition which is still unknown. It is evident however, that there are two types of substances, some soluble in water and some soluble in fat, which are essential to the diet in preventing the onset of certain so-called dietary diseases. They are found in the husks of natural grain, in vegetative tissues like the leaves of green vegetables, and in butter, olive oil, and other natural fats.

Dietary Diseases.—A dietary deficiency in these substances has been established as a cause of beri-beri, rickets, and scurvy and it is thought to be the cause of pellagra.

Beri-Beri is found in Asia among the people who make a large part of their diet of polished rice. It is characterized by progressive emaciation, loss of weight and of strength. There is neuritis, the inflammation of the nerve trunks being followed by degeneration resulting in prostration and frequently in death. This disease has been induced experimentally by feeding birds upon polished rice. The birds showed a typical polyneuritis with inactivity, loss of weight, and muscular contraction. But when fed with an aqueous extract of rice bran the birds immediately recovered. In the same manner the disease among human subjects has been stamped out by using unpolished rice or by introducing a mixed diet.

Pellagra, a somewhat similar disease, has been found to be most common in countries where corn is the chief article of diet and where the husk and germ of the grain are removed before grinding. The disease is characterized with erythema, digestive and nervous disturbances. Sometimes cachexia, muscular weakness and insanity develop. The evidence is not as clear in this case but here again the disease seems to be produced by a diet of the pure starch of a cereal food to the exclusion of the leafy and vegetative tissues which contain the needed vitamine.

Scurvy, which is produced by a lack of fresh foods in the diet, was a common disease upon ships in the days before it was possible for them to carry a larder stocked with fresh, canned, or cold storage vegetables and meat. It has now largely disappeared. The introduction of the potato was an important factor in driving the scourge from Europe, by increasing the quantity of fresh vegetables eaten. Infantile scurvy occasionally results from the exclusive use of pasteurized milk. The feeding of a small quantity of orange juice, however, is a preventive and a cure. The characteristics of this disease are weakness, soreness of the gums, loosening of

the teeth, bleeding from the mucous membrane and friability of the bones.

Rickets is a dietary disease which results in the absence of normal growth in the child and which is apparently due to the lack of one or more vitamines. The symptoms include restlessness, fever, profuse sweating, emaciation and alteration in the growth of the bones. The head becomes bulky, the sides of the thorax flatten, the sternum projects and frequently there is a bending of the spinal column and long bones.

Our knowledge of these subjects, although incomplete, has given an added importance to the place of fresh vegetables and natural fats in the diet of children. The presence of these substances is essential for health although the vitamines themselves are needed only in minute quantities.

Balanced Diet.—Proper nutrition not only demands that these six kinds of foods be secured but that they be secured in proper proportions. This proportion may be judged roughly from the composition of milk which is the perfect food prepared by nature for young infants. Human milk contains approximately 2½% protein, 3½% fat, 6½% sugar and 0.25 % inorganic salt. We find therefore that water makes 86% of the infant's diet. Vitamines are also present in mother's milk but as in any diet in analytically negligible quantities.

The quantity of the three important types of food which are necessary for a normal individual has usually been computed on the basis of the number of calories necessary for the individual. A calorie is the amount of heat required to raise a kilogram of water one degree centigrade. It is possible to measure the energy output of the body in calories and to determine the heat energy in the same way. Each gram of protein, fat, and carbohydrate material when oxidized yields respectively 4.1, 9.3 and 4.1 calories.

It is found that the energy requirement varies according to the age and size of the individual and the amount of physi-

cal work performed. The child needs more protein food than the adult because new tissue is being produced. Murlin points out that ice cream represents the proper proportions for adults since it is milk plus sugar and fat, the protein being diluted. The child also needs relatively more fuel food for the work done because the small body has more surface to the unit weight and the amount of food required varies more

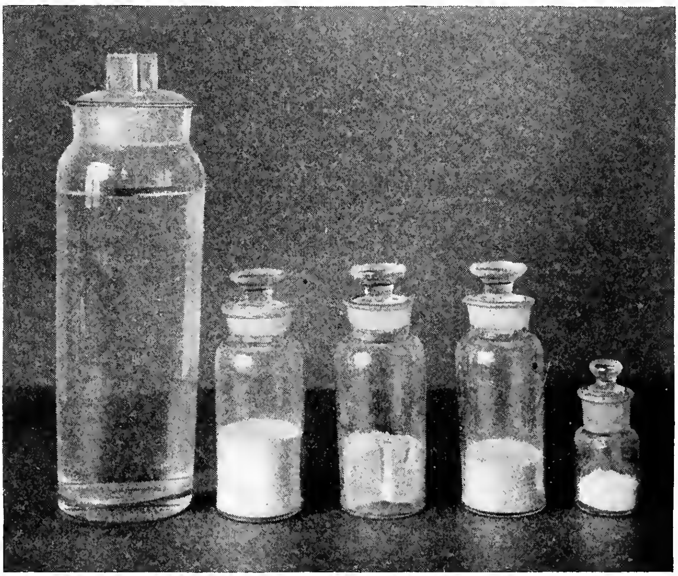


Fig. 9.—The composition of cow's milk. The bottles are arranged from left to right to show the actual amounts of water, sugar, fat, protein and ash in a quart of milk.

directly with the surface of the body than with the weight of the body.

Men doing muscular work usually secure 3,500 calories or more in their daily ration. People of sedentary occupation find something less than 2,500 to be sufficient. The following table taken from Stiles' *Human Physiology* gives a suitable average food combination for the sedentary individual:

Protein	75 grams or	300 calories
Fat	50 grams or	465 calories
Carbohydrate	375 grams or	1500 calories
Total		2265 calories

Another way to estimate the food requirement in protein, carbohydrates, and fat would be to state the amount of some well-known food necessary to provide a sufficient quantity of each. If all the protein in the day's diet were to be secured

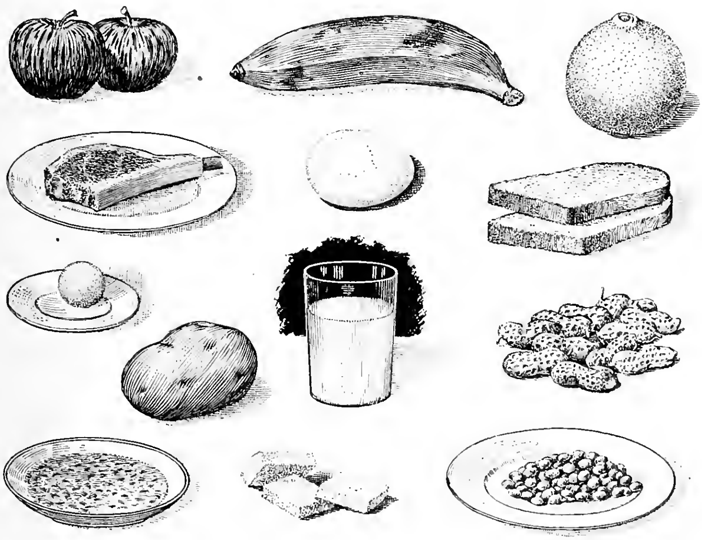


Fig. 10.—Portions of different foods each yielding approximately 100 calories of heat energy. They include: an ordinary serving of beans, 3 large lumps of sugar, 1 large banana, 11 double peanuts, 1 large egg, 1 potato, 1 chop, 2 slices of bread, 1 orange, 2 apples, ⅔ of a glass of milk, 1 pat of butter, and an average serving of oatmeal.

from lean beefsteak, all the fat from butter, and all of the carbohydrate from rice the individual would need to eat approximately the following quantities of these foods in order to secure the gram or calorie requirement mentioned above:

Beefsteak	⅘ lb. (375 gr.)
Butter	⅛ lb. (59 gr.)
Rice	1 lb. (475 gr.)

The Varied Diet.—The whole tendency of recent dietary study has been to show that variety in diet is necessary. A variety of proteins is desirable because each protein is made up of a different combination of amino acids, which we have called the building blocks; and in order to be sure to include in the food all of the amino acids needed by the body many different proteins should be eaten. Again we have seen that fresh vegetables, leafy tissues, meats and natural fats contain "vitamine" substances which are little known chemically but which are necessary for a proper balancing of the diet.

Furthermore, man must choose a reasonable amount of hard foods in order to exercise the jaw and preserve the teeth. A certain amount of bulk must also be secured to furnish a stimulus for peristalsis in the intestines and maintain the normal activity of the bowels. This is secured by eating fruit, vegetables and other bulky foods poor in nutritive value.

2. DIGESTION

Good digestion is something more than the mere swallowing of the proper number of grams of the various kinds of food each day. To get the best results the food must be appetizing, the person must be in the proper mental state, the food must be eaten in suitable fashion, and bodily activities must not seriously interfere with digestion.

Digestion and the Emotions.—The recent work of Dr. Cannon upon the emotions (*Bodily Changes in Pain, Hunger, Fear and Rage,* by Walter D. Cannon; D. Appleton & Co., 1915) has shown us clearly the importance of proper psychic conditions in normal digestion. Nowhere else is there such a good statement of the facts at hand. Commenting upon the previous work of Pawlow with dogs Cannon says:

> By the use of careful surgical methods he was able to make a side pouch of a part of the stomach, the cavity of which was wholly separate from the main cavity in which the food was received. This pouch was supplied in a normal manner with nerves and blood vessels and as it

opened to the surface of the body, the amount and character of the gastric juice secreted by it under various conditions could be accurately determined. * * * In some of the animals thus operated upon an opening was also made in the esophagus so that when the food was swallowed, it did not pass to the stomach but dropped out on the way. All the pleasures of eating were thus experienced, and there was no necessity of stopping because of a sense of fullness. This process was called "sham feeding." The well-being of these animals was carefully attended to, they lived the normal life of dogs, and in the course of months and years became the pets of the laboratory.

By means of sham feeding Pawlow showed that the chewing and swallowing of food which the dogs relished resulted, after a delay of about five minutes, in a flow of natural gastric juice from the side pouch of the stomach—a flow which persisted as long as the dog chewed and swallowed the food, and continued for some time after eating ceased. Evidently the presence of food in the stomach is not a prime condition for gastric secretion. And since the flow occurred only when the dogs had an appetite, and the material presented to them was agreeable, the conclusion was justified that this was a true psychic secretion.

Other experiments upon dogs have shown that merely the sight or smell of a favorite food will start the pouring out of the gastric juice. Analogy teaches us that good cookery not only makes our mouth water but it makes our stomachs water as well. This initial psychic secretion of gastric juice is important because the continuance of its flow during digestion is brought about by the reaction of its acid or digestive products upon the mucous membrane of the duodenum.

The saliva produced when the mouth waters not only starts the digestion of starches but it also assists in enabling us to taste our food, for materials are tasted only when they are dissolved.

To quote further from Dr. Cannon's excellent description:

The conditions favorable to proper digestion are wholly abolished when unpleasant feelings such as vexation and worry, or great emotion such as anger and fear, are allowed to prevail. This fact, so far as the salivary secretion is concerned, has long been known. The dry mouth of the anxious person called upon to speak in public is a common instance; and the "ordeal of rice," as employed in India, was a practical utilization of the knowledge that excitement is capable of inhibiting the salivary flow. When several persons were suspected of crime, the con-

secrated rice was given to them all to chew, and after a short time it was spit out upon the leaf of the sacred fig tree. If anyone ejected it dry, that was taken as proof that fear of being discovered had stopped the secretion, and consequently he was adjudged guilty.

What has long been recognized as true of the secretion of saliva has been proved true also of the secretion of gastric juice. For example, Hornborg was able to confirm in his little patient with a gastric fistula the observation by Pawlow that when hunger is present the mere seeing of food results in a flow of gastric juice. Hornborg explained the difference between his and Pawlow's results by the different ways in which the boy and the dogs faced the situation. When food was shown, but withheld, the hungry dogs were all eagerness to secure it, and the juice very soon began to flow. The boy, on the contrary, became vexed when he could not eat at once, and began to cry; then no secretion appeared. Bogen also has reported the instance of a child with closed esophagus and gastric fistula, who sometimes fell into such a passion in consequence of vain hoping for food that the giving of food, after the child was calmed, was not followed by any flow of the secretion. * * *

The studies of Bickel and Sasaki confirm and define more precisely this inhibitory effect of strong emotion on gastric secretion. They observed the inhibition on a dog with an esophageal fistula, and with a side pouch of the stomach, which, as in Pawlow's experiments, opened only to the exterior. In this dog Bickel and Sasaki noted, as Pawlow had, that sham feeding was attended by a copious flow of gastric juice, a true psychic secretion, resulting from the pleasurable taste of the food. In a typical instance the sham feeding lasted five minutes, and the secretion continued for twenty minutes, during which time 66.7 cubic centimeters of pure gastric juice were produced.

On another day a cat was brought into the presence of the dog, whereupon the dog flew into a great fury. The cat was soon removed, and the dog pacified. Now the dog was again given the sham feeding for five minutes. In spite of the fact that the animal was hungry and ate eagerly, there was no secretion worthy of mention. During a period of twenty minutes, corresponding to the previous observation, only 9 cubic centimeters of acid fluid were produced, and this was rich in mucus. * * *

On another occasion Bickel and Sasaki started a gastric secretion in the dog by sham feeding, and when the flow of gastric juice had reached a certain height, the dog was infuriated for five minutes by the presence of a cat. During the next fifteen minutes there appeared only a few drops of a very mucous secretion. * * *

Recently Oechsler has reported that in such psychic disturbances, as were shown by Bickel and Sasaki to be accompanied by suppressed se-

cretion of the gastric juice, the secretion of pancreatic juice may be stopped, and the flow of bile definitely checked. All the means of bringing about chemical changes in the food may be thus temporarily abolished.

Dr. Cannon describes most interestingly his own experiments which show that the excitement in pain, fear and rage also prevent the normal contractions of the stomach and intestines.

Even indications of slight anxiety may be attended by complete absence of the churning waves. In a vigorous young male cat I have watched the stomach for more than an hour by means of Roentgen rays, and during that time not the slightest beginning of peristaltic activity appeared; yet the only visible indication of excitement in the animal was a continued quick twitching of the tail to and fro.

Physicians who treat great numbers of digestive disorders frequently receive a clinical history of indigestion with symptoms of heaviness in the stomach after eating, as though the food failed to pass on to the intestines. Such a case exhibits an increasingly aggravated condition. This type of nervous or *emotional indigestion* in specific cases has been shown to be definitely related to unfavorable mental states. The accompanying diagram shows the way in which the autonomic nervous system reaches and affects the various parts of the body.

It should be added here that the secretion of adrenalin and the increase of the sugar content of the blood are important and complicating factors. Not only is digestion completely inhibited by the stronger emotions but the blood and muscles are supplied with more fuel and the circulatory and nervous systems are toned up to enable man to exert his utmost physical strength as he was usually called upon to do during his more primitive existence and during the long period of evolution.

The Hygiene of the Emotions.—Certain conclusions inevitably follow. Digestion ensues much more readily if the food eaten is appealing in sight, odor and taste. Among people who, because of illness or for some other reason have a dainty

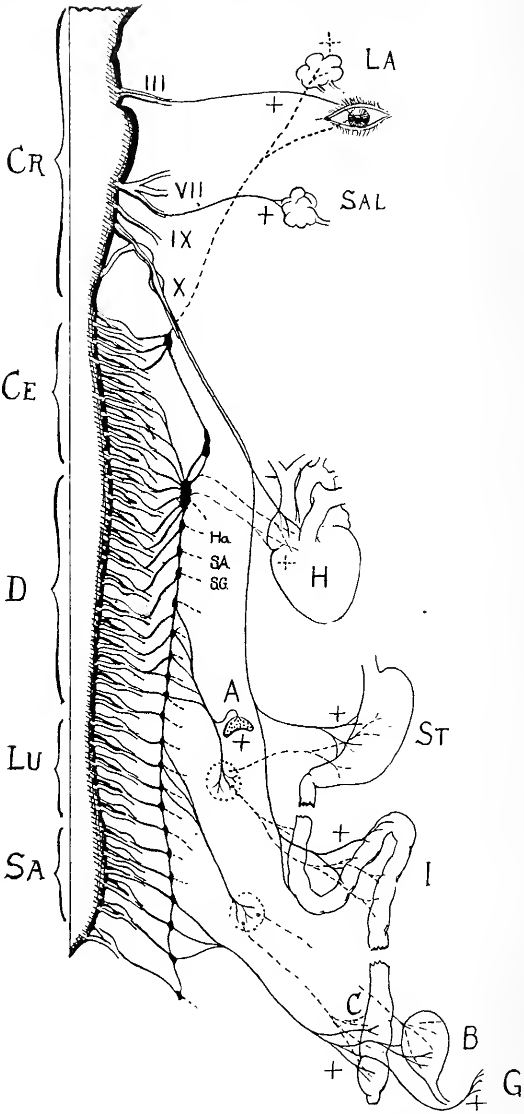


Fig. 11.—Diagram showing the most important distributions of the Autonomic Nervous System. One-half of the brain and spinal cord is represented at the left. The preganglionic fibers of the Autonomic Nervous System are in solid lines; the postganglionic in dash lines. The cranial, cervical, dorsal, lumbar, and sacral divisions of the nervous system are indicated by the letters Cr, *Ce, D, Lu,* and *Sa,* respectively. The organs indicated as affected by the emotions include the lachrymal glands, the pupils of the eyes, the salivary glands, heart, hair, superficial arteries, sweat glands, adrenal bodies, stomach, intestines, colon, bladder, and genitals. (After Cannon.)

appetite special care in these particulars is very important. It is also clear that the forced feeding of children, the unnecessary punishment of children at the table, and feeding immediately after the child has been in a passion are all unhygienic. Among adults it is equally important that the meal should be pleasant and free from anxiety, worry and ill-feeling. Otherwise a vicious cycle will be set up and the man who begins by worrying at his meals or thinking intensely upon the problems of his work will set up a mild indigestion which will in turn lower his efficiency, aggravate his work by depleting his physical condition and initiate him into the unstable and unenviable fraternity of neurasthenics.

"Enjoy your food" is an excellent maxim. Enjoy your meal, the surroundings, the company and the food. Choose food which you will enjoy eating and eat slowly. If food is eaten under proper conditions it is much more likely to be eaten properly.

Mastication.—The digestion of starches and sugars and the preparation of these substances for absorption is begun in the mouth. If these foods are swallowed without proper chewing and the addition of saliva their normal digestion is impossible.

Important beginnings of protein digestion take place in the stomach by the action of the peptic secretion from the walls of the stomach and these are carried further by the action of the pancreatic juice and other fluids. These fluids must act upon the exposed surfaces of foods and therefore if a piece of meat the size of a marble is cut into particles the size of coarse sand by proper chewing, the surface area available for digestive action is increased many fold. The principle adopted by Horace Fletcher, who selected foods which appealed to his appetite and chewed all food till it was practically liquid in the mouth, is sound but more difficult of successful practice for the poor and busy man than it was for Mr. Fletcher.

Water With Meals.—There has been much discussion about the advisability of drinking quantities of water with the meals. There seems to be no reason why water taken with the meals should be injurious unless it is used to wash down dry food in order to save the individual the trouble of chewing or unless it is taken at a low temperature and in such quantities as to cool the stomach and slow up the action of the secretive tissues of the stomach wall.

Rest After Eating.—In experiments recorded above Pawlow shows that the secretion of gastric juice lasted for twenty minutes after the end of a five minute period of sham feeding. Bickel has also shown, in the case of a girl with a closed esophagus and gastric fistula, that gastric secretion continued active for some time after eating even when no food had entered the stomach. We have also seen that the effects of the unpleasant emotions and mental states are sufficient to inhibit the secretion of digestive juices after the process is once started. For these reasons and because of the withdrawal of blood from the digestive tract to the muscular organs in the case of hard manual labor we may conclude that an after-lunch rest period, postponing for at least one-half hour the return to active labor, is highly desirable.

3. ASSIMILATION

Assimilation Defined.—The processes of nutrition which take place after the food has been absorbed by the walls of the digestive tract and taken into the circulation are chiefly the functions of the absorption and combustion of the food material in the tissues and the elimination of waste from the body. These processes include the use of the gaseous food, oxygen, and the elimination of the chief end products of combustion, water, carbon dioxide and urea. Nitrogen is eliminated through the kidneys, in the form of urea, carbon dioxide through the lungs, and water through the lungs, kidneys and skin.

Oxidation.—Apparently assimilation is not impaired by a lack of oxygen due to poor ventilation. As we shall see in describing ventilation, the injurious effects of poor air are not due to the chemical content of the air but to an entirely different set of factors. The supplying to the tissues of this all important gaseous food depends much more upon proper breathing and suitable exercise. These matters will be considered in more detail under the hygiene of action.

Eliminating the Body Wastes.—The elimination of urea is made easier by limiting the protein diet so as to avoid an excess of nitrogen for elimination by the kidneys and by drinking large quantities of water in order to reduce the concentration of the urine. It has been shown that the action of the kidney in withdrawing the salts of urea from the blood and combining them in a much more concentrated form in the urine involves definite energy consumption.

The evacuation of the bowels is mainly the elimination from the body of substances which have never passed through the walls of the alimentary canal since the secretions which are thrown into the digestive tract constitute but a small part of the feces. But we should not neglect to reaffirm the importance of so regulating the diet and the habits that defecation may be regular in order that the material in the rectum and lower bowel may not become inspissated and absorbed to such an extent that the blood is loaded with these poisonous waste proteins and the vitality of the individual temporarily impaired.

Autointoxication.—We have seen that the emotions may so interfere with digestion that the process is not properly commenced or if underway it is brought to an abrupt stop. When this occurs food may remain in the stomach for many hours instead of being passed on to the intestine. The bacteria, which are always present in the digestive tract in countless numbers, are especially active when digestion and normal absorption is delayed so that the fermentations which they set up in the intestine produce gas and cause pain. Under

normal conditions the nitrogenous food is largely absorbed before the material reaches the colon but if digestion has not been sufficiently completed these proteins do reach the large intestines and undergo putrefaction with the consequent production of poison which will be absorbed into the blood and produce the ill effects of *autointoxication.*

The signs of beginning or transient autointoxication are drowsiness, inertia, headache and a feeling of fatigue. If it is long persistent nervous depression, hardening of the ar-

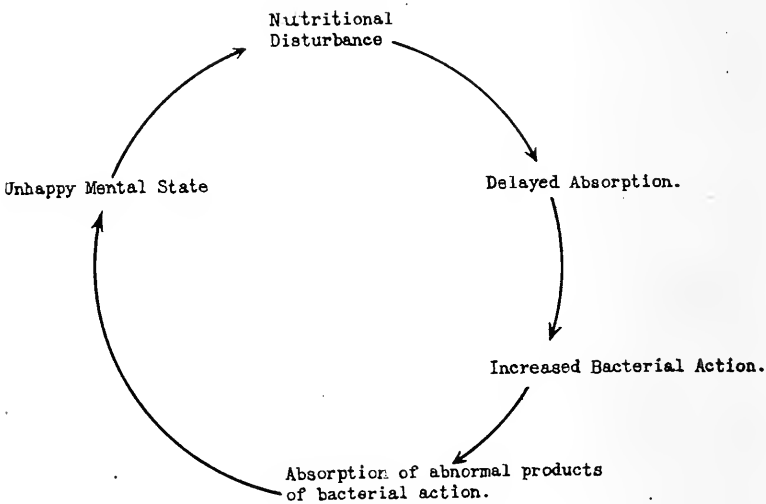


Fig. 12.—The worry-autointoxication cycle.

teries, anemia, and arthritis may result. The body will recover from a single attack of autointoxication but it may be readily seen that long continued grief or anxiety may produce a chronic condition which in turn would increase the nervous trouble setting up a vicious cycle.

Overeating as well as the emotions will cause autointoxication and it is possible that the slightly excessive consumption of food may in the long run produce injurious effects. Fortunately for the individual greatly overloading the stom-

ach is likely to be followed by a mild diarrhea. In the case of autointoxication the occasional use of a cathartic is beneficial but it should not be used too often. Moderation and temperance in eating especially in the eating of protein foods is most important. The drinking of sour milk or the regular ingestion of lactic acid bacteria is a measure aimed to prevent the putrefaction associated with autointoxication by substituting lactic acid fermentation as the dominant type of bacterial action in the alimentary canal.

Constipation or the slow movement of food along the intestinal track may or may not be associated with autointoxication. Its seriousness is overemphasized in the ever present advertisements for cathartics, but the condition is harmful and should be avoided by the use of plenty of water, by eating "roughage" such as fruit and vegetables and by suitable exercises. A habit of at least one movement a day at a regular time should be established. The habitual use of cathartics or enemas should not be encouraged.

Food Poisoning.—The newspapers frequently recount cases of "ptomaine poisoning" in which persons suffer from extreme pain, diarrhea, and frequently from forcible vomiting, coupled with a high fever and extreme prostration. Ptomaines are supposed to be poisonous substances produced by the bacterial decomposition of nitrogenous food under certain conditions. It is lately much less common to hear of ptomaine poisoning and many cases which have been so reported have been found upon investigation to be due to bacterial infection. In fact the existence of specific ptomaines is in question. Recent experiments upon the quality of canned foods have completely failed to disclose the presence of ptomaines or other poisons.

Certain people are poisoned by particular foods such as pears, eggs, lobsters, etc. This type of poisoning is hard to understand but it may be a type of anaphylatic reaction as suggested in the chapter on Immunity.

Obesity.—The tendency to become overweight is no doubt constitutional although of course it is true that adipose tissue can only be acquired by the continued consumption of more fuel than is used by the body.

There are two ways to combat overweight, by reducing the amount of food or by increasing the oxidation. When we are not eating we are losing weight at the rate of about one ounce an hour. Fasting will reduce weight but it is extremely unpleasant. Sometimes drugs are given which destroy one's appetite but they too are likely to be unpleasant and to injure digestion. The oxidation of food may be increased by exercise but, unfortunately for the person who is trying to reduce, exercise is followed by an increased appetite and a greater consumption of food.

The use of a diet high in protein is sometimes recommended. This decreases the amount of food eaten because protein quickly satisfies hunger and also accelerates the process of oxidation. This procedure always places too heavy a burden upon the kidneys; and perhaps a better and more consistent plan is to substitute, in so far as possible, coarse and bulky foods like fruit and vegetables for the fuel foods like sugar, starches and fats. In this way hunger can be satisfied without taking too much nutritive material.

Under-Eating.—Common and bothersome as are the problems of overweight cases of under-eating are perhaps more serious and more frequent. Many people suffer the loss of physical and mental vigor because through carelessness in their eating habits or lack of means, they fail to secure the food that they should have. Women, particularly, often fail to secure suitable and nourishing food because of the expense or because of the trouble of preparing food for themselves when they are alone.

Such a person is in many respects the exact opposite of the individual who is overweight. The underfed person drags himself about—underweight, pale, sensitive to cold, morose, querulous, and pessimistic. He sleeps lightly and works with-

out enthusiasm and without surplus energy. The overfed person is perhaps not very diligent but he is cheerful, optimistic, of ruddy countenance, and a heavy sleeper. To secure the golden mean in diet is greatly to be desired but perhaps it is better to err slightly on the side of plenty.

CONCLUSIONS

Many factors are involved in the proper regulation of the diet. The protein must be applied in suitable quantity and variety. The quantity of the fuel foods must be adjusted to the kind of work being done. Plenty of water is essential. The necessary inorganic salts must be secured from various sources and vitamine substances must be provided. The emotions must not be allowed to impair the digestion and proper habits of eating should be acquired.

Every person should study himself and learn what foods best agree with him. He should experiment to find the best arrangement for hours and types of meals. In general men doing mental work find that they can do best when the breakfast and lunch are not too heavy and the hearty meal is eaten at night. Lunch particularly should be light, if work is to be done early in the afternoon. Many but not all people work best on a light breakfast. But in all these things personal habits, bodily constitution, and daily schedule are important and although there are some general rules every person must learn what best agrees with him.

CHAPTER III

THE HYGIENE OF ACTION

Two Kinds of Bodily Activity.—Independent activity of the organism begins with birth and ends only with death. Even the person who avoids physical evercise carries on a variety of muscular activities including the beating of the heart, breathing, and the functions of walking, riding, sitting, standing, eating, gesturing, talking, etc. Some of these activities are involuntary and others are so simple as not to require careful attention, but in all these activities and in a contrasted group of activities which we may term active physical exercise, there arise certain problems of hygiene.

EXERCISE

Voluntary muscular activity or exercise will be first considered. The professional man or the individual engaged in a sedentary occupation will do well to give careful attention to the beneficial effects of regular and proper exercise and to the dangers incident to its neglect. Exercise is more essential to his happiness than mental development is to the happiness of a man employed in active physical labor.

It is a pernicious fallacy to regard healthful and vigorous exercise as an unnecessary burden in the day's work merely because the changed living conditions since the days of our forefathers have rendered mental activity the usual, and physical activity the unusual mode of life for the professional, business and clerical classes. Especially among the intellectually inclined there is danger that the desire for a good physical condition of the body may stop with the envy of those who possess such a body or with an attempt to secure the same stimulation in another way or by an easier road, in using mas-

sage, alcoholic stimulants, drugs and patent medicines, instead of learning the real delight and joy of a proper physical condition resulting from well-directed exercise.

What Exercise Does for the Body.—Briefly, what are the real and actual effects of regular physical exercises upon the body? In the first place it is a most important stimulus to the *circulation* of the blood and the lymph. The movement of the muscles and other organs exerts a massaging action on these two streams in the capillaries and lymph spaces; and the increased respiration exerts a suction upon the venous blood into the great veins near the heart by the same bellows-like action with which air is drawn into the lungs. This increased breathing is also important to the *lungs* themselves in filling air spaces which under normal conditions may not be used, and particularly in inflating the apical regions of the lungs.

The increased bodily activity increases the *oxidation* going on in the body. The extent of this action is shown by the fact that the output of carbon dioxide is increased from three to ten times by muscular activity whereas the digestive process only increases its output one-fifth. This carbon dioxide is thrown off through the lungs. Water is another waste product and the *skin* is cleared by the generous excretion of the sweat glands and the consequent softening of the horny layers.

The most generally obvious aspect of exercise is the building up of the general *muscular system* which constitutes two-thirds of the bulk and weight of the body. Muscle fibrils increase in size when used but when unused they decrease until hardly more than the connective tissue remains of what should be a strong and vigorous muscle. Nor is this unimportant for the man of sedentary occupation, because for everyone there are emergencies which must be met by unusual physical energy. Running for a street car, running upstairs, or sudden emergencies which occur in the professional activity of the dentist or physician, require physical energy and often considerable muscular strength. This need of reserve strength

is especially important in the case of the *heart* which like the skeletal muscles is built up and strengthened by proper physical exercise. In the emergencies cited above and in certain diseases like pneumonia it is primarily important that the heart is sufficiently strong to withstand the strain. In fact, in disease the strength of the heart often determines the question of life or death.

But the other internal organs also gain vastly from physical exercise. The viscera are relieved from serious *internal congestion* which is likely to take place in the body of a sedentary individual and which predisposes the internal organs to diseased condition. The stagnation of the blood and lymph in the large vessels running from the digestive organs to the heart interferes with digestion, circulation, and the sense of physical well being. *Digestion* itself is aided by the increased peristalsis produced by the churning activities of these organs and by the increased use of the abdominal muscles.

To anyone who has learned to enjoy physical exercise it is not necessary to say that the general toning up of the bodily activities, the improvement of the circulation and all the attendant changes mentioned above, produce a beneficial effect on the *mental tone.* Of equal importance is the effect upon the *heat-regulating mechanism.* Muscular activity opens the small blood vessels of the muscles and the region near the skin and contracts the blood vessels of the internal viscera. It is upon our ability to make these changes that we rely in large part for our bodily adjustments to changes of temperature. A trained and adaptive heat-regulating mechanism is therefore essentially important to the general health.

In summarizing the foregoing we may list the beneficial effects of muscular exercises as (1) an aid to circulation, (2) an aid to oxidation, (3) an aid in the elimination of waste, (4) clearing the skin, (5) strengthening the muscular system, (6) aiding digestion, (7) improving the mental tone, (8) relieving internal congestion, (9) strengthening and en-

larging the lungs, (10) strengthening the heart, and (11) improving the heat regulating mechanism.

Types of Physical Exercise.—The type of physical exercise which one may take depends upon his physical fitness, age and inclination. It is far better to build a good body in youth and to maintain its efficiency throughout life, but it is never too late too begin bodily improvement provided this is done in a sane and proper manner. To allow a horse to remain in the stable for weeks then drive it a hundred miles in a day would spoil the animal; yet many people expect the human mechanism to accomplish similar feats, in rare and immoderate exercise. Some who rarely exercise go to excess because when the opportunity to exercise offers itself there is a joyous outlet of pent-up energy and the individual does not realize (at least until he tries to get out of bed the next morning) that an unused muscular system has its limitations. Others overdo because they have once been athletic and do not realize that absence from regular exercise has depleted their powers of endurance.

The first requisites of the most helpful exercise are that it should be regular, enjoyable, and adapted to the individual. The person who religiously resolves to attend the gymnasium at least three times a week finds that after the second or third week it begins to pall on him. If he is taking routine exercises, he goes through a definite set of mental processes. As the hour approaches for him to enter the gymnasium he has a feeling of dislike for the task and is sure that he would prefer continuing his office activities. Through moral force however he persuades himself to go, and after completing his exercise and being refreshed by a shower bath he feels so invigorated that he firmly resolves to enter the gymnasium six times a week instead of three. Yet the same compulsion must be exercised the very next day if he is to resume his exercises.

The strengthening of the physical and mental fiber will certainly repay this individual if he persists in the regular

routine of exercise. Gymnasia are invaluable assets in the life of the city. If, however, the exercise can be varied so that the man takes a delight and looks forward to the time when he will have an opportunity to exercise, much is accomplished. With some individuals the innovation of athletic games accomplishes this result. Such a man takes a keen joy in a contest; in making himself expert and proficient in a particular way. Still another type of mind dislikes any activity which is not productive. Hunting, fishing, exploring, training horses, gardening, carpentering, etc., all appeal to such a man and fortunate is he who can elect his ideal exercise from this group. These activities, however, are not always available to the occupant of a five room flat; so perhaps we should say most fortunate is the man who can become fond of any of the types of physical exercises mentioned.

Rhythm in Exercise.—More should be said about the nature of the exercise itself. It should involve rhythmic and not continued muscular contraction. A type of exercise like tennis, baseball, or football is a much more general and invigorating bodily exercise than the mere lifting of heavy weights. The exercise should be such that free play is granted to the various parts of the body. The lungs should be free to expand to their fullest extent, and the movements of the trunk should be free and easy. That exercise is most helpful which is sufficiently varied to call into use a great number of the muscles of the body. Above all things the exercise should be reasonably vigorous.

Walking.—Walking, which is an excellent exercise and available to everyone, should never be confused with loitering or strolling. Fast walking in the open, especially in the country, is invigorating, restful and has the added advantage of making the man interested in his surroundings and in the wonders of the natural world which he was meant to enjoy. Mere strolling even though it be in the open is not proper exercise and is tiring rather than restful. Air is good and essential but the mere breathing of fresh air cannot take the place of physical exercise.

ORDINARY BODY ACTIVITIES

The other phase of the Hygiene of Action, which we mentioned in the beginning of this discussion, concerns the proper use of the body in the ordinary affairs and conduct of life. This involves also the matter of figure, bodily shape, and physical force; because these depend upon the proper coordination and balance of the muscular system.

Figure.—Good figure and proper carriage are important not only in the personal appearance of the individual, directly affecting his personality and the estimate set upon his ability by the casual observer; but they are also important to health as deformities injure and restrict adjacent organs. The body is largely made up of opposing sets of muscles which tend to move the various parts in the opposite directions like the flexor and extensor muscles of the lower leg or arm. Similar sets of muscles alter the position of the neck, the chest, the back and the jaw. We shall see how the improper use of particular muscles may distort the normal figure of the body. This is particularly noticeable respecting the shoulders, the neck, the back, the abdomen and the feet.

Round Shoulders.—Round shoulders have become so common among large groups of sedentary workers that there is danger that we may conclude that they are normal. The round-shouldered individual himself is likely to feel that he has assumed an abnormal position when he straightens up. When straight he looks unnatural merely because he is not in his habitual or customary position. It is only when we look at the erect posture of a child of three or four years or the bearing of the well trained soldier that we realize how odious is round-shoulderedness compared with the natural contour.

This condition is brought about by drawing the shoulders forward through the contraction of the muscles of the chest and the disuse of the muscles of the back so that finally the muscles become set in this position with the chest muscles contracted and the back muscles relaxed leaving the shoulders in a forward position, cramping the upper part of the chest

and limiting the breathing. This deformity is brought about by a careless attitude at the desk or by leaning forward over one's work, and the individual must develop consciousness of physical position in order to avoid incorrect posture. Corrective exercises, in consciously throwing the shoulders back with the arms widely extended to one side or in raising the arms above the head at the same time drawing a deep breath and dropping the arms slowly during the period of exhaling, keeping the hands well to the rear, are effective in correcting this condition.

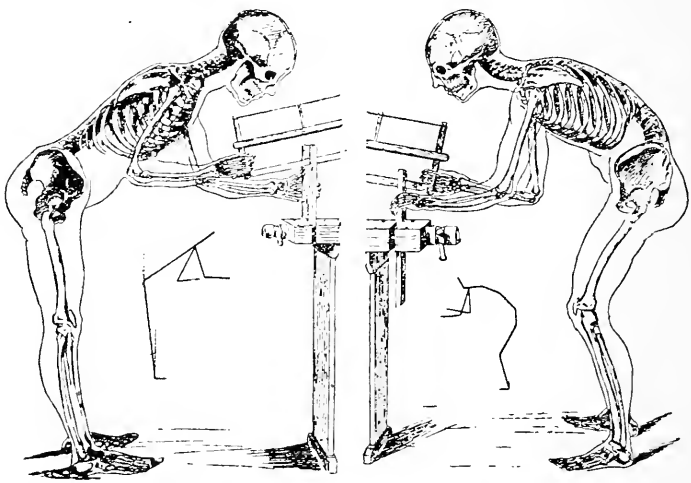
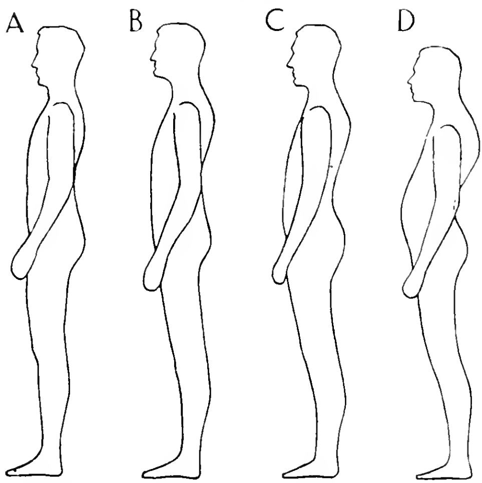


Fig. 13.—Good (left) and bad (right) postures. The main lines of the body are shown in diagram and it is easy to see that the position at the right would be much more tiring. (Burgerstein.)

Carrying the Head Forward.—Another malady which often accompanies round shoulders is the fault of carrying the head too far forward. The neck becomes accustomed to an abnormal position and is no longer erect. This again is due to the weakness of the muscles which hold the head back, and the set contraction of the muscles which pull the head forward. One of the first corrective exercises for both these conditions is that of flattening the back against

a straight, perpendicular wall. The individual backs up to a door or wall and places himself in such a position that the calves of the legs, the hips, the shoulders, and the back of the head lie flatly against the wall. This is approximately the normal posture and if a man walks away in this position

TRACINGS MADE DURING EXAMINATION OF 700 HARVARD FRESHMEN



Group A—7.5% Group B—12.5% Group C—55% Group D—25%

Fig. 14.—Posture chart showing the result of the examination of Harvard Freshmen.

Group A.—Good mechanical use of the human body. 1. Head straight above chest, hips and feet. 2. Chest up and forward. 3. Abdomen in or flat. 4. Back usual curves not exaggerated.

Group B.—Fairly good mechanical use of the human body. (Note changes from Group A.) 1. Head too far forward. 2. Chest not so well up or forward. 3. Abdomen very little changed. 4. Back very little changed.

Group C.—Bad mechanical use of the body. (Note changes from Group A.) 1. Head forward of chest. 2. Chest flat. 3. Abdomen relaxed and forward. 4. Back curves are exaggerated.

Group D.—Very bad mechanical use of the body. (Note changes from Group A.) 1. Head still farther forward. 2. Chest still flatter and farther back. 3. Abdomen completely relaxed. "Slouchy." 4. Back all curves exaggerated to the extreme. (Lee.)

and maintains it for some time, repeating the exercise every morning he will gradually accustom himself to the proper position of the head and shoulders and this position will become the natural one. Another way to exercise the muscles at the back of the neck is to clasp the hands be-

hind the head and force the head back against their pressure.

Spinal Curvatures.—Another common fault in posture is the abnormal curving of the spine either laterally or backward at the region of the thorax or forward at the region of the abdomen. This latter is often associated with protrusion of the abdomen by increase in fat and the relaxing of the ventral abdominal muscles.

The curvature of the back may be prevented in large part by the exercise of trying to make oneself as tall as possible, holding the back straight and rising on the toes with arms extended over the head, stretching the arms and body. The objectional "pot belly" condition may be successfully prevented and largely overcome by such exercises as lying flat on the floor or bed with arms folded and raising the feet and head alternately. Lateral curvatures arise from sitting in a leaning position and are most common in children who sit improperly at school.

Deformities of the Feet.—Less conspicuous but none the less important deformities are those which are found in the feet. In selecting shoes man seems to conclude that nature made a mistake in making the foot broad at the toe and he endeavors to make it over into a wedge-shaped organ; while woman tries to improve upon nature by walking upon the toes and elevating the heels instead of walking upon the flat of the foot. If you will observe an infant or small child you will find that the toes are flexible and move sideways and backwards and forwards to a great degree. When a child walks the toes "dig into the ground." Held in by the shoes in later life this early flexibility and the original shape of the foot are largely lost. Especially in people who, like dentists, are required to remain on their feet for many hours a day, do we find painful and harmful foot conditions.

There is a natural arch running from the heel to the ball of the foot and a small reverse arch from the toes to the top of the instep. These arches are held in position by a

complex group of muscles. If these muscles are not used or if they are so bound up that they are not given proper free play, the weight of the body, centering in front of the heel, tends to break down the arches and produce a condition known as flat foot. This defect will be rather prevalent until common sense rules fashion and people demand proper shoes.

To take proper care of the feet the shoe must be as wide as the foot, the heels must be low and broad, the toes and uppers of the shoes must be flexible, there must be room for activity at the toes of the boot and the foot must be held in such a position when walking that it is carried straight ahead. In a normal foot the line drawn through the long axis of the great toe should also pass through the heel.

The foot must be given proper exercise to strengthen the muscles of the ball of the foot and the arch. Dig the toes into the ground when you walk, practice the ordinary gymnastic exercise of "heels raised, knees bend," thus calling the muscles of the foot into play. Do not wear the shoe or the garter so tight as to cause congestion of the blood in the foot. All of these things are very important in securing fair treatment for one of the most abused members of the body.

The public must learn that from the aesthetic standpoint a small foot with a pointed toe and high heel is not the ideal foot.

Such is not the foot of the Apollo Belvedere nor that of the Venus of Milo. It is simply a deformity, belonging in the same category with the constricted waist, and far more harmful to its possessor than the ear or nose ornaments of the Hottentot. No hygienic lesson is more important than that clothing should fit the body and not the body the clothing.—*Sedgwick.*

Ocular Hygiene.—The proper use of the eyes and ears forms an important part in the ordinary activities of life although somewhat removed from the subject of muscular action. Both of these complicated sense organs require expert

attention if there is anything seriously wrong. Their importance and their complexity both demand this. We should remember that headaches and even the nausea accompanying the so-called "sick headache" may be produced by defects in the eyes which are perhaps more often congenitally abnormal than any other organ.

We can do much to take care of the eyes by being careful to use a steady and not a flickering light when we read, by choosing paper which is dull and not of a glossy finish, and by avoiding in so far as possible, the use of any print so fine that it is necessary to hold the book less than eighteen inches from the eyes. Occasionally the eyes may be rested from the work immediately at hand by changing the focus, looking out of the window, and focusing the eyes upon some distant object. This is merely an act of muscular relaxation to prevent the strain which would otherwise be caused by the continual focusing of the eyes upon near objects.

Breathing.—By the process of breathing the blood acquires oxygen and discharges carbon dioxide and the body throws off moisture. Nearly all of the carbon dioxide produced in the body is discharged through the lungs and about one pint of water a day is thrown off in this manner.

The red blood corpuscles are like tiny boats hauling oxygen from the lungs to the tissues and exchanging it there for carbon dioxide which is brought back to the lungs and discharged into the air which is being exhaled. But the cargo of these boats is never limited entirely either to CO_2 or oxygen for both gases are found in considerable quantity in either the arterial or the venous blood. It is as though our "ships" were always carrying a certain amount of each as ballast and emptying only a part of their compartments at the lungs and in the tissues. One hundred volumes of arterial blood contain about 20 volumes of oxygen and 38 volumes of carbon dioxide. One hundred volumes of venous blood contain about 12 volumes of oxygen and 45 volumes of carbon dioxide. It seems that there is always enough

of proper "cargo" at either "loading point" for the boat to take on its usual load; for a person can breathe without discomfort in air which has so much carbon dioxide that a match will not burn in it. On the other hand the rate of oxidation is not increased when a person breathes pure oxygen. Only when the blood has fallen below standard in disease or during extreme exertion does the breathing of pure oxygen have any advantage over the breathing of normal air. Here it helps to restore the standard of the blood.

The rate of breathing is not affected by the chemical composition of the air. It is controlled by the concentration of carbon dioxide in the blood through its effect upon a special regulating nerve center. Exercise, therefore, naturally increases the rate of respiration and this is the best way to take breathing exercises.

When one practices *forced breathing* he is likely to become dizzy or faint. The concentration of carbon dioxide in the blood is reduced below the point which should be maintained as a stimulus to the nervous tissues. The most immediate effect is upon the breathing center which ceases to send out the necessary stimuli with the result that breathing is stopped or slowed down until sufficient carbon dioxide has accumulated again. Breathing sufficiently forced to produce dizziness is not to be recommended. It is well to breathe deeply at a normal rate, however, and to keep the chest expanded. Deep breathing increases the capacity and vigor of the lungs and by keeping the chest well expanded the figure is improved, the heart and great blood vessels are given sufficient room and the diaphragm is allowed a freedom of action which is highly beneficial to the internal organs.

Bathing.—The first function of bathing is to keep the skin and body clean. Otherwise the skin glands will leave upon the surface solid substances which are odorous and putrescible. Cleanliness not only keeps the skin healthy and

vigorous; it avoids the presence of dirt which is a possible carrier of disease; and it is directly related to the self-respect of the individual.

Perhaps something should be said of the temperature at which baths are taken. The *hot bath* opens the pores of the skin by stimulating the activity of the skin glands. It follows that its too frequent use may make the skin dry by removing the oil and that such a bath leaves the individual highly susceptible to exposure to cold. It should not be taken too often or before going out into the open air. On the other hand, a hot bath or foot bath before going to bed helps to break a cold by bringing the blood to the skin and stimulating the circulation.

If taken under proper conditions the *cold bath* is followed by a warm glow as the heat-regulating mechanism sends the blood back to the skin to neutralize the effect of cold. Such baths should not be prolonged over a minute and should be taken in a warm room when the skin is warm and followed by a good rub. They should not be taken within one hour after eating. Some find that cold baths use too much of their energy. By disturbing the circulation of the internal organs they may rarely result in constipation when taken regularly each morning.

The *indifferent bath* in which the water is from 80 to 90 degrees F. lacks both depressing and stimulating effects and is a good type of daily bath for many people particularly those who are not the most robust.

Clothing.—If the daily activities are to be performed with comfort suitable clothing is necessary. The great essential in securing proper clothing is to provide constant ventilation for the body, that is, a continual change of the "aerial blanket." The type of clothing depends upon the nature of the fiber from which the clothing is made. The mesh of the round woolen fiber makes a cloth in which there are innumerable spaces filled with air and therefore the clothing is warm and not a good conductor of heat or cold.

On the other hand, cotton fabrics are made from flat fibers readily pressed together in such a way that air is excluded from the meshes. The cotton cloth therefore, allows a ready exchange of air about the body and is a good conductor of heat. Rubber fabrics are not porous at all and allow no passage of air from one side to another.

Woolen clothing is much warmer than cotton and is suitable for the person who is doing out-of-door work or riding in the open during winter weather. It is an undesirable fabric for underclothing for people who are working indoors in the city. Our offices and shops are more likely to be too warm than too cold and the perspiration of the body in such a temperature is not readily evaporated through woolen. It is absorbed by a thick woolen garment and the body does not secure the relief it should have. At the end of four or five hours in the office, however, the garment is saturated with perspiration and all of the spaces formerly filled with air have become filled with water so that the underclothing is now a very good conductor of heat and when the person emerges into the cold air the water in the garment cools and the person is chilled in his cold damp clothes. For the man in town, therefore, it is much better to wear light underclothing and compensate for this by putting on heavy outer garments when emerging into cold air. If he is careful to walk briskly and keep up his bodily activity while out of doors or waiting for a car he has another means of increasing his bodily heat by increasing the oxidation process in the tissues.

CHAPTER IV

THE HYGIENE OF THE CENTRAL NERVOUS SYSTEM

The proper care and conservation of that exceedingly complex machine, the central nervous system, upon which depend the sensations of consciousness and the efficiency of our mental and physical activities, is highly important.

Function.—Through physiology and anatomy we early learned of it as a telephone-like system of communication having the central station in the brain, from which orders are constantly being sent during our waking moments, and having substations in our reflex and sympathetic nervous systems which are capable of handling minor emergencies flashed in as impressions from those parts of the body connected with each substation. The higher centers are subject to a continual bombardment of impulses and stimuli from the sense-organs.

This is a system composed of living substance which demands rest between periods of great activity and like other living tissues it increases, through use, its facility in the work it has to do. But if it is *overused* or *abused* it becomes hypersensitive. Stimuli which ought not to go beyond the substations are flashed through to the head station and trifles interfere with important activities. The person is irritable and the system is unable to carry out its normal functions.

Without taking time to review the structure or function of the system in detail we shall consider the hygiene of the nervous system first in health and later in disease. It is common experience that the nervous system becomes tired at the end of the day's work. We know that the activities of the normal life place demands upon it which must be compensated by periods of rest. Our interest here concerns the efficient functioning of the nervous system and the important

ways in which rest and efficiency are secured by the normal and healthy individual.

Concentration.—Perhaps the most important characteristic of the efficient nervous system is the power of concentration upon the task at hand. This is expressed in another way as the power of inhibiting undesirable stimuli. It is equally valuable in work and in rest. In work the individual inhibits from the center of consciousness those thoughts which are not germane to the subject in hand and also those stimuli which arise from the surroundings, trying to make their way to the center of consciousness through the portals of sight, hearing, touch, and perhaps taste and smell. In the efficient mind such stimuli and the inconsequential thoughts which arise from their associated ideas are rigidly excluded from the conscious thought.

Recreation has the reverse process and the individual severely forbids thoughts and worries of his work to crowd in upon the enjoyment of the pleasures which he has allowed himself. For those people who, like great executives, are obliged to shoulder heavy responsibilities and are weighed down with numerous cares, the power of complete relaxation may be a saving grace. The criticism which has sometimes been placed upon Lincoln and other men of this type for brief periods of light-heartedness in the midst of great problems is entirely unjust and unreasonable.

The power of concentration is so intimately linked with efficiency and personal success that one may well ask how it may be secured or improved. Perhaps the most valuable aid is good health for with it the body is freed from minor pains, irritations and morbid sensations which are constantly breaking into the train of thought of the physically unfit, opening the way for other distracting influences.

Fondness for one's work is another important factor, since the work itself is making a constant appeal to the mentality and the volition. That is why there is a unity between the things people like to do and the things they do well. The ar-

rangement of one's workshop or desk in such a way that but one thing at a time is before the worker is important, and often it is of material assistance to occupy the hands with a pencil in making notes or sketches or with models, apparatus or instruments in studying technique. A man will do well to study the lighting, furnishings and equipment of the work place to eliminate distracting stimuli such as might arise from the reflected light of a glossy page, uncomfortable chairs or confusion of material.

Habit.—Habit is another important factor in the conservation of the nervous system. The processes of eating and dressing are exceedingly difficult for the young child, but by the adult they can be accomplished while the mind is devoted to a more pleasant plane of thought than the necessary mechanical operations which are being performed. In the same way many activities connected with the daily work may be relegated to the realm of habit and thus the energy of the nervous system may be spared. Energy-saving habits are highly desirable but there are some dangers here. It goes without saying that good and not bad, hygienic and not unhygienic habits should be formed.

But apart from this psychologists have pointed out a group of so-called indifferent habits like the continual use of particular words and phrases, the lack of reasonable variety in dress and recreation. They have pointed out that old age is a fixity of the nervous system which such long-continued habits have limited to particular channels of thought and action. If this is true it is possible to postpone old age by occasionally breaking up these habits in a determined fashion and freeing the mind from those ruts.

Sleep.—To the normal person sleep is the great refreshing agent for the nervous system. The nature of this invaluable process still awaits complete explanation. There are two other types of unconsciousness; namely, intoxication by drugs, in which sensations are blocked from reaching the central nervous system, and fainting, where consciousness is lost be-

cause of an insufficient blood supply in the brain. Perhaps sleep has an element of both these types of unconsciousness, involving an altered brain circulation and the accumulation of the poisonous waste of bodily activity.

The unconsciousness of sound sleep carries with it the complete relaxation of the body. This is the time when the body tissues make good their losses and for these reasons no satisfactory substitute for sleep can be found. It is probably this complete relaxation and its accompanying reduction of oxidation which makes a person chilly upon falling asleep in his chair or upon the couch in a room which has previously seemed warm enough.

No doubt other factors than nervous fatigue are important in determining the amount of sleep required, since it varies greatly in individuals and is markedly greater in the young than in the old. Perhaps the most important factor here is assimilation. Heavy eaters are characteristically heavy sleepers, whereas "Fletcherites" testify that the great reduction in the amount of food eaten and the completeness of its mastication has reduced the amount of sleep which they find necessary.

From seven to eight hours sleep is surely enough for the normal and healthy adult person. Nor should one conclude because there is an indisposition to rise in the morning that he has had too little sleep, it may be laziness and not weariness. It has been found by experiments that during the first two hours sleep is the heaviest and after that the person is waked more easily. This does not necessarily mean that the later hours of sleep are not equally restful but merely indicates that the nervous threshold has been lowered by the rest already secured.

The difficulties in going to sleep promptly and in sleeping soundly do not usually exist for the normal individual if he is physically tired. Wakefulness often seems more serious than it really is because the person may hear the clock strike regularly but yet obtain several hours of light and dozing

sleep. Apart from physical exercises which induce bodily fatigue and secure a healthful sleep it is sometimes possible to avoid sleeplessness by the eradication of disturbing factors. The bed should be comfortable, the room dark and quiet, and the ventilation adequate. The person who sleeps where there is continuous noise, may say that he can sleep soundly, but he is probably doing his nervous system an injustice nevertheless because he is partly wakened several times during the night. The banishment of exciting or worrying thoughts and the concentration of the mind upon inconsequential and humdrum things, with the conscious attempt to relax the muscles of the hands and limbs and to adopt a slow rhythm of breathing, may also aid in promptly falling to sleep.

Dreams.—The subject of dreams suggests itself. We must leave their philosophy to the psychologist, limiting ourselves to a brief statement of their importance from the hygienic viewpoint. There are two types of dreams, the remote and the recent. The remote type deals with experiences widely separated from the activities of the day, the other type deals with the worries and problems of our waking hours. It is the latter and not the former which should be a warning to us that our nervous system is not in a rested and normal condition.

Change of Work.—Another method of resting the nervous system is by a change of work which puts in play a wholly different set of nerve structures. The man who has worked over a machine all day and is thoroughly tired may rest his nervous system as well as refresh his muscular system by playing baseball or tennis, but one must be careful, in this connection, not to commit the fallacy of assuming that nervous excitement, when it involves the nervous structures already tired, is rest. The man who is tired from driving an automobile may forget his weariness by watching a moving picture of hairbreadth escapes; but he is not rested thereby and it is only the strong stimulation of the overtired nervous structures which causes him to forget his fatigue temporarily. It is

probably unfortunate for the nervous system as well as for family life that the habit of quiet home reading has been abandoned for a variety of exciting social amusements.

Sunday Observance.—Sunday observance is a most important safeguard for the nervous system. In some experiments carried out at the Harvard Medical School (reported by Martin, Withington and Putnam, *American Journal of Physiology,* 1914, Vol. XXXIV) it was shown that the sensory threshold, as measured by the least electric shock which could be felt through two fingers of the same hand, was lowest on Monday and highest on Saturday. In other words, the irritability or sensitiveness of the nervous system was highest after the day of rest or change in activity and was gradually reduced throughout the week. Apparently there is a cumulative fatigue of the nervous system by the work of the day which is only offset by Sabbath rest. This may account physiologically for the fact that one day in seven has been set apart by people of nearly all races and religions as a day of rest and worship. It is certain that the observance of Sunday as a day of quiet when, for a time at least, the thoughts may be fixed upon immortal truths and upon things entirely separate from the struggle of the week is much to be desired in the care of the nervous system.

Neurasthenia.—We have considered the care of the nervous system under the normal conditions of life and may now turn our attention to a discussion of the abnormalities of the *overworked* nervous system. We have hinted at the cause of this condition in mentioning cumulative fatigue which increases during the six working days of the week. When the strain upon the nervous system becomes too great and outdistances the normal rate of repair this cumulative fatigue results in serious disturbances ending in neurasthenia.

There are a variety of causes for neurasthenia. In a few cases there are hereditary defects and the individual is handicapped from the beginning of life with a highly irritable, hair-trigger nervous mechanism which was his unfortunate legacy

from one or both of his parents. But in most cases inefficiency, discontent and lack of the ordinary degree of courage, perseverance, and kindliness are subject to hygienic control in some degree. The causes which will next receive consideration include overwork, emotion, bodily defects, eye strain, poor environment and the like.

Overwork.—By overworking the mind, we mean putting too great a tax upon its endurance and not a too strenuous endeavor to concentrate the mental facilities. It is a case of too long hours and not too vigorous mental work. There is a maxim for students in regulating their hours of work that "8 plus 2 equals 10 but 10 plus 2 equals 8" when measured by the effective work done. In other words, there is a time limit in taxing the nervous system.

Emotions.—The discussion of emotion in previous chapters has already suggested that not work but worry is harmful. The effects of the emotion upon the central nervous system are varied and important.

If we trace the initial difficulty of indigestion due to the emotions, we find that the food lies in the stomach into which no digestive juices have been poured until abnormal and harmful decomposition changes begin to take place. Then as the food is finally passed into the intestines there is further decomposition because the protein digestion has not proceeded to a suitable degree in the stomach, and the bacteria in the intestines decompose food substances into soluble and harmful end products, which are absorbed from the walls and produce that mild poisoning known as autointoxication. These deleterious compounds have a specially marked effect upon the central nervous system. Autointoxication may be produced by continued unfavorable emotions like worry, fear, grief and pity, and it is increased by overeating, especially the overeating of nitrogenous foods. It is one of the important factors in deranging the nervous system.

The emotions have other relations to the nervous system than those connected with digestion. As Cannon clearly

showed, the emotions were designed as an aid to activity, by increasing the amount of sugar in the blood, producing a marked secretion of adrenalin, bringing digestion to a halt and increasing the capacity of the skeletal muscles. It is normal and probably more beneficial to the individual when his strong emotions find an outlet in action for then the impulses are translated into muscular activity. The external bruises of the school boy who fights are perhaps not as serious as the internal injury to the nervous system if there is no outlet for his anger. Even when a person has remained inactive there is some energy resulting from emotion or excitement, for these stimuli, upon reaching the muscles produce balanced contractions which may be indicated by tenseness of the muscles and features.

It would seem therefore that for the normal and especially for the sluggish individual a reasonable amount of emotional excitement may be harmless and even desirable. But in so far as environment may be regulated to eliminate constant and undesirable emotions this should be done and whenever possible our emotions should be given a physical outlet, especially those noble emotions which are produced by beautiful music and other forms of art, by the glories of nature, and the eloquence of gifted speakers. These stimuli should be translated into practical beneficent action.

Bodily Defects.—There are many bodily defects which injure the central nervous system to a large degree. We remember that pain has the same effect upon many organs of the body as do rage, fear and anxiety, and it seems reasonable that many mild bodily ills. which are tolerated when they should be corrected, will create continuous and harmful sensations in the central nervous system. Decayed teeth, troubles of the feet, such as fallen arches, ill-fitting shoes, corns and blisters, the wearing of orthodontia appliances by children, nasal obstruction with tonsillar and adenoid trouble, hemorrhoids, and uterine displacement are examples of conditions which should receive prompt attention not only for their own

sake but for the injury which they do the nervous system.

Eye strain is another important example. The nearsighted individual who is trying in vain to focus the eye, which is too deep, in such a way that normal vision shall be effected; the farsighted individual, who must put an extra strain upon the eye to focus it for near objects; and the individual with astigmatism, who is always straining the eyes in the attempt to secure a clear image, are all bound to feel the effects upon the nervous system. On the other hand the correction of these difficulties often makes a new man or woman so far as temperament and congeniality are concerned. Perhaps it is the duty of the family to insist that such conditions are corrected for, since they have to live with the afflicted, they may have some rights in the matter.

Stimulants.—Stimulants also should be considered in their effect upon the nervous system. Physiologists now agree that *alcohol* is not a stimulant but a narcotic. The reason for the feeling of exhiliration which follows a mild dose of alcohol is due to the paralyzing of the higher centers which have to do with inhibition. When these centers are shut out from the rest of the nervous system the individual no longer feels the restraint of dignity and propriety. He gives free rein to his impulses and believes himself to be the soul of wit and the prince of goodfellows even when his activities are most asinine. As Professor Stiles has suggested, alcholic stimulation is like taking the brakes off on a train which is traveling down hill. It is easy to reach the lower level but it is hard to regain the heights.

In a study of the intellectual capacity of a group of students before and after using alcohol the subjects were given certain simple mathematical problems which were accomplished in a given time and the amount of errors checked. Later in the day after having partaken of small quantities of alcohol, the students were given similar problems to do and upon emerging from the room all testified that they had done the work more quickly and rapidly than in the first instance.

The actual results were different from their expectations, however. They had taken longer to do the work and had been less accurate. The temporary banishment of care and the sense of obligation for the moment is a pleasure and may make the individual a more gracious social being but the resumption of responsibilities after the taking of alcohol is not so easy, and good health rather than this alternative should be the basis of our social graces.

Many of the *patent medicines* have been shown to have an alcoholic content greater than champagne as the following table shows:

ALCOHOL COMPARISONS

Beer	4½%
Ale	8%
Champagne	10%
Swamp Root	9%
S. S. S.	15%
Varnesis	15%
Pinkham's Vegetable Compound	15%
Warner's Safe Remedy	15½%
Tanlac	16%
Pepto-Mangan	16%
Hood's Sarsaparilla	16½%
Vinol	18%
Manola	18%
Wincarnis	19%
Paine's Celery Compound	19⁸⁄₁₀%
Peruna	20%
Wine of Cardui	20%
Plant Juice	20%
Hostetter's Bitters	25%

It may not be inappropriate therefore to classify such substance as stimulants especially since in many cases their real medicinal value is seriously in question. The man who is foolish enough to prescribe such a remedy for himself instead of seeking the advise of a good physician for his ills, ought to know what it really is which makes him "feel better" when he drugs the system with a patent medicine cocktail.

Tea, coffee, and *cocoa* are not narcotic but are true stimu-

lants and their effect on the body is to increase activity. For most people their use in reasonable quantities is not harmful. There are people, however, who find that one or the other of these drinks is a definite injury. To be of greatest value they should not be used regularly but only when some unusual demand is to be placed upon the nervous system.

The Neurasthenic.—We should consider what is meant by the functional disorder neurasthenia or as it is called in some of its milder stages, nervous fatigue or nervous prostration. This is a type of disease which shows no lesions upon postmortem examination. It is functional rather than structural. As the state of nervous impairment progresses the individual indicates his condition by his demonstrativeness. He appears to be in a mild state of intoxication and indeed the accumulation of fatigue products in the brain may act in somewhat the same fashion as an alcoholic stimulant and may manifest itself in bodily movements and muscular contractions.

The neurasthenic is dissatisfied with everything around him because he is in an extremely sensitive condition. The room is too hot or too cold, there is too much light or too much noise. Impulses are sent to all parts of the body upon the slightest provocation. The skin is readily flushed or takes on the goose-flesh appearance, the heart is irregular, the digestion faulty, and the urine widely variable in composition. And perhaps worse than all is the subjective state, which is one of self-pity and disregard for the feelings of others, a condition separated from insanity only by the fact that all the worries have some foundation—though often slight—in fact, and are not wholly imaginary. The neurasthenic is often not responsible for his condition. It may have been brought on by circumstances over which he had no control. Nevertheless, it is extremely difficult to treat him with unmitigated kindness. It must be remembered that the troubles of which the neurasthenic complains are real to him and he

must be treated with the consideration, tolerance and temperance which this broad perspective would suggest.

Treatment.—In describing the cause of neurasthenia as nervous fatigue the remedy has naturally suggested itself as suitable rest for the nervous system. Bodily defects must be first corrected and then physical exercise, which will concentrate the mind upon other things than the worries of the invalid, and sufficient sleep are important factors. Nervous fatigue yields more readily to these corrective measures in its incipient than in its latter stages.

The dentist may frequently be of aid to the neurasthenic by encouraging him in a program of physical upbuilding and by assuring him that better teeth and the correction of other bodily defects will improve his health and relieve his nervousness. Such a patient in the dentist's chair should be treated with kindness, sympathy, and encouragement but with some degree of firmness.

CHAPTER V

THE HYGIENE OF REPRODUCTION

The Problem Defined.—The problem of reproduction in its broadest sense involves the replacing of one generation by another in the best possible manner. This includes compliance with the laws of heredity, a knowledge of the effects which the conduct of life may have upon the offspring, the best possible supervision over the hygiene of pregnancy and the early days of infant life, and the proper regulation of the sex life.

HEREDITY

Our knowledge of heredity has expanded rapidly during the past few years. We have here, however, only sufficient space to mention some of those facts which are important in guarding against the perpetuation of undesirable traits and physical conditions in offspring. The development of the subject has come from two lines of study, researches upon human heredity (eugenics) begun by Galton and researches in plant and animal breeding (genetics) begun by Mendel.

Mendelian Inheritance.—Mendel's law enunciates the principle that opposing characteristics in the male and female parents do not blend in the offspring but the heredity units or genes remain distinct in the germ cells of the offspring recombining in future generations according to the law of probability and chance.

To illustrate by an example from Mendel's work: when a pea plant which produces peas having a green color is crossed with one producing peas of yellow color all the peas produced in the first generation are of a yellow color but if plants of this first hybrid generation are crossed among themselves the peas produced in the second generation are in a definite ratio of three yellows to one green.

This law may be illustrated also from animal heredity. Among guinea pigs the crossing of a black strain with a white strain produces in the first generation only black offspring but if these pigs are bred among themselves the resulting offspring are in the ratio of three black pigs to one white one.

These results are most clearly understood in terms of the presence and absence theory which assumes that the yellow pea and the black guinea pig possess factors in the germ cell for yellow and black color, respectively, and that these color

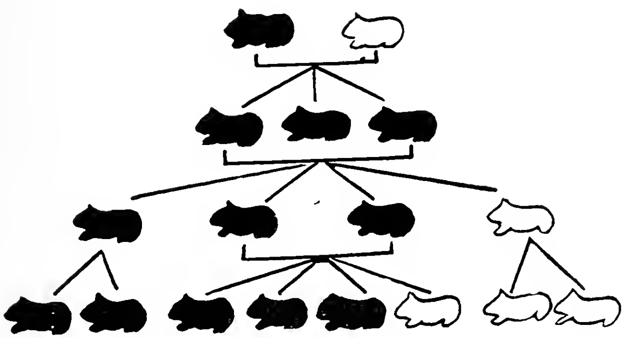


Fig. 15.—Inheritance in guinea pigs showing where the color (black) dominates over another color (white). (Kelicott.)

factors are lacking in the green pea and the white pig. Such a characteristic appears whenever it is present in one or both of the germ cells united to create the new individual. We have here an explanation of the fact that offspring of the first generation all show a particular characteristic which has been inherited from one of the parents. We call such a characteristic as blackness in the guinea pig a dominant characteristic and the white color a recessive characteristic. The following diagram illustrating the inheritance in guinea pigs shows why the first generation is completely black. All of the ova produced by the female guinea pig contain the characteristic for blackness and although they are united with sperms which lack this characteristic for blackness they still

carry the characteristic to the fertilized egg which is the beginning of the existence for the new individual.

It may help us to understand the law better if we consider the explanation afforded by the general belief that the chromosomes are bearers of the hereditary characteristics. The reader will recall from elementary studies of biology that the chromatin or deeply staining substance of the cell nucleus arranges itself into short threads called chromosomes whenever there is a cell division. The number of these chromosomes is constant for any species of animal. The number in all of the *body* cells is twice that in the mature *sex* cell. In other words, the final maturation processes of sex-cell development allow a separation of the chromosomes into two sets or groups so that there *may be* two kinds of sperms and two kinds of ova so far as the inheritance or non-inheritance of any characteristic is concerned.

Returning to our example of the inheritance of color in guinea pigs we assume that the black color is produced by a special factor for pigmentation which is present in the sex cells of the black pig and absent in those of the white pig. It would appear that this factor is present in a chromosome inherited from the female parent but absent in the corresponding chromosome inherited from the male parent. It would therefore be present in all of the body cells of the hybrid but when this pair of chromosomes again become separated in the production of sex cells they would produce cells of different types. Therefore, we may have from this generation of hybrids, ova containing a factor for pigmentation and ova lacking the factor for pigmentation. Likewise, we may have spermatozoa with this factor and others without it. so that there are four possibilities in the mating of cells within the uterus which must be in reality a matter of chance. The female cell with the character for blackness may unite with the male cell also having that characteristic and in that case the offspring produced receives the same inheritance from both parents so far as this characteristic is

concerned, and therefore it is a "pure black" which will always produce black offspring. There is an exactly opposite possibility, namely, a union of two cells neither of which has

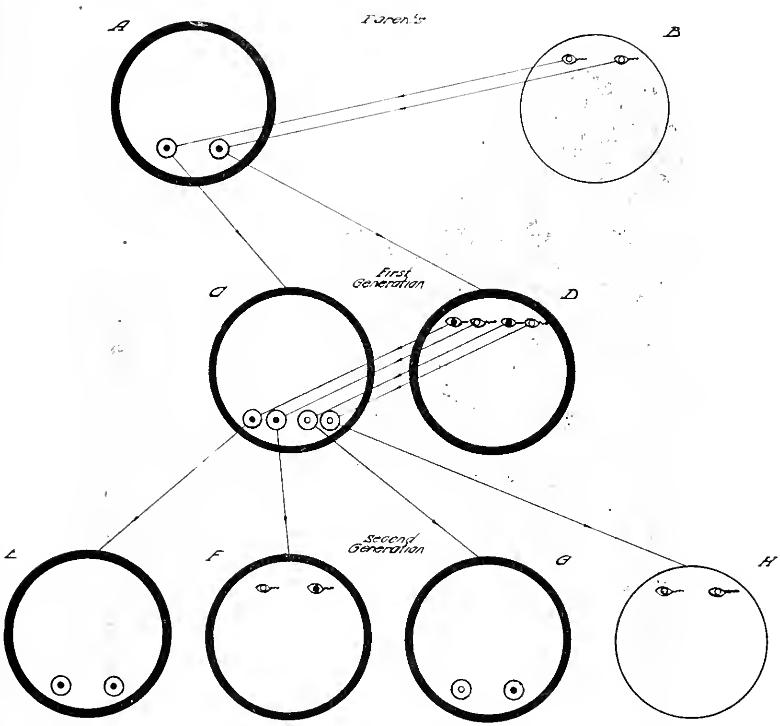


Fig. 16.—Diagram illustrating the mechanism by which the unit factor, color, is inherited in guinea pigs. Animal A is a black female of pure stock. Such an animal is called homozygous and all of its sex cells are alike in carrying the unit character in question. Animal B is a homozygous white male; none of the sex cells have the characteristic for blackness. Animals C (female) and D (male) are hybrids. In each case half of the sex cells carry the characteristic for blackness and half of them lack this characteristic. When C and D are crossed the offspring of the second generation are in the ratio to three black to one white. The diagram illustrates each possible chance-combination of sperm and egg and it will be seen that, of the second generation animals, E is homozygous, F and G are heterozygous like C and D, and H is a homozygous white.

the characteristic for blackness. Such a union results in a white pig of pure stock so far as color is concerned.

Two other possibilities involve the mating of a *female* cell *containing* the characteristic with a *male* cell *lacking* the char-

acteristic or the exactly opposite condition. In either case we have a hybrid individual like the parents, that is, one and only one of the pair of chromosomes with which the color

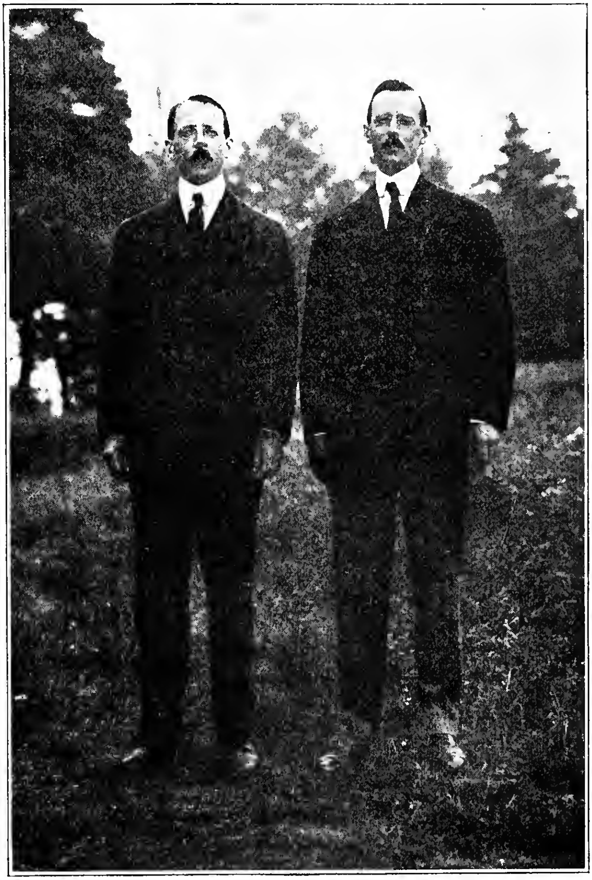


Fig. 17.—Eminent Twins. Edwin P. Grosvenor (left), prominent New York lawyer, and his twin brother Gilbert Grosvenor (right), President of the National Geographic Society. (Photograph from Gilbert Grosvenor.)

factor is connected contains the characteristic. Such animals are black in color because a pigment factor is present, although only in half quantity, and if again bred among them-

selves we once more have a 3-1 ratio, that is, three black offspring to one white. Naturally since this ratio depends upon probability or chance it is not exact. However, the greater the number of offspring the more exact is the ratio. This three to one ratio is in reality a ratio of one pure black: 2 hybrid blacks: 1 pure white. Such an hereditary trait as the one just described is called a unit character.

The study of genetics has taught us that many characteristics are inherited like the unit factors mentioned above. That being the case, it is obvious that these characteristics can be mingled by crossing different types and can be recombined in new combinations. For example, it might be possible to cross a round red tomato with a yellow pear-shaped tomato and by continued breeding and careful selection secure a pure strain of red pear-shaped tomatoes. This indeed is the principle and the explanation of the wonderful work accomplished by Luther Burbank in plant breeding.

We can but marvel at the miracle of nature displayed in heredity. From each mating of sex cells, all of which look exactly alike when viewed with the highest power of the microscope, nature produces an individual different in characteristics from any other of the millions of people who inhabit the globe. It is difficult to explain how so many characteristics can be arranged spacially in the tiny germ cell unless we can conceive that these characteristics are caused by the infinite varieties in molecular pattern which are possible in the highly complex chromatin substances.*

The mechanism of inheritance is in no way better illustrated than in the complete similarity of identical twins which result from the separation of the embryo in its two-celled stage. Such twins must therefore receive identical hereditary factors. Compare the records of the Grosvenor twins. As students at Amherst College they divided highest honors in

*Miescher has shown that a molecule of albumen with forty carbon atoms may have as many as one billion stereoisomers, in protoplasm there are many kinds of albumen and other proteins, some with probably more than 700 carbon atoms.—*Conklin.*

the classroom and on the tennis field. Both have since achieved distinction, one as builder and director of the National Geographic Society, and the other as Assistant Attorney-General and partner in one of the most important law firms in America. They have never varied more than a pound in weight. In college their grades never varied more than one-tenth of one per cent. Although absolutely dependent upon glasses, each can wear the other's. Most of their tastes are similar.

How Sex in the Offspring Is Determined.—There has always been considerable speculation as to how sex in offspring is determined, because the question is of vital interest to parents who have a preference for either a son or a daughter; and it is interesting to find that the explanation offered by Mendelian studies in heredity and the microscopic studies of cell structure, which have for the most part been developed by Morgan, Wilson, and other American investigators, indicate that sex in the offspring cannot be controlled. We said previously that the body cells of animals contain twice as many chromosomes as do the sex cells. We must modify this general statement by saying that in the male of certain species this is not true. In such animals, of which it seems that man is an example, there is a chromosome which students of heredity speak of as the sex chromosome.

Investigators believe that among humans all body cells in the female contain 48 chromosomes. This is true of the sex cells up to the time of the maturation process when the reduction takes place and the ripe ova are found to have 24 chromosomes. Among males the body cells appear to contain 47 chromosomes and when the maturation process takes place the odd chromosome or sex chromosome as it is called goes to but half of the cells resulting from the last division. We therefore have two kinds of spermatozoa in man, one having 23 chromosomes, the other having 23 chromosomes plus the sex chromosome or 24. When the 23 chromosome sperm unites with the egg we have the beginning of a new individual of 47 chromosomes or a male. When the 24 chromosome

sperm unites with the egg we have a new individual of 48 chromosomes or a female. Femaleness, then, is produced by the presence of two sex determiners, that is, it is an added characteristic superimposed upon maleness.' The determination of sex is therefore a matter of chance.

Sex-Linked Characters.—Apparently the causative factors of certain other characteristics are located in the chromosome which determines sex and such unit characters are called sex-linked. Remembering the nature of the sperm cells de-

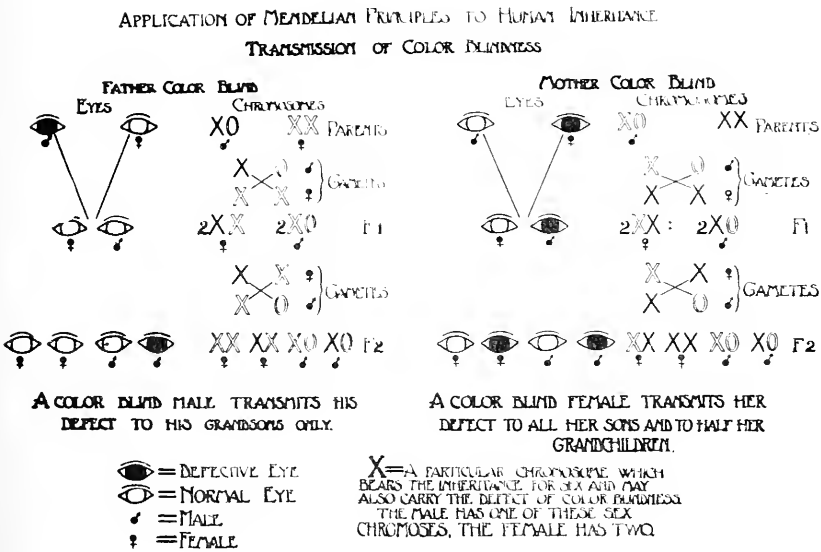


Fig. 18.—Transmission of color blindness.

scribed above, we see that a sex-linked character in a man might be transmitted to his daughter but not to his son, if it were a dominant character. If it were a recessive character it could not be transmitted to any of the children from the father provided the mother were normal in this respect. Recessive sex-linked characteristics when transmitted by the mother would be apparent only in the sons.

Color-blindness gives an example of this kind of inheritance

and since it is a recessive characteristic a color blind man need have no fear of transmitting the defect to his children if he marries a woman with no taint of this defect. This defect, however, may be passed on through his daughters to his grandsons but not to his granddaughters. The color blind woman on the other hand if married to a normal man even though she inherited color-blindness from both her parents would not transmit the defect to her daughters. Her sons, however, would all be color blind. The fact that this characteristic is located in the sex chromosome explains why color-blindness is more common in men than in women. Being recessive it is not apparent in the female unless it is inherited from both parents, while in the male it is directly received from the mother since it is not counter-balanced by a normal inheritance from the father.

Inherited Diseases and Abnormalities.—There are several unit characters which have already been discovered in *human heredity*. Some of these are diseases but fortunately for the race these diseases are usually recessive and their evil effects may be counteracted by intermarriage with a normal stock. It must be remembered in this connection that pure strains for many characteristics are almost never to be found where inter-racial marriages have taken place for several generations.

The following table shows some of the conditions in man which are inherited according to Mendelian principle:

MENDELIAN INHERITANCE IN MAN

(*Teratological and Pathological Characters*)

Dominant	Recessive
GENERAL SIZE:	
Achondroplasy (Dwarfs with short stout limbs but with bodies and heads of normal size)	Normal
Normal Size	True dwarfs (With all parts of the body reduced in proportion.)

HANDS AND FEET:	
Brachydactyly (short fingers and toes)	Normal
Syndactyly (Webbed fingers and toes)	Normal
Polydactyly (Supernumerary digits)	Normal
SKIN:	
Keratosis (Thickening of Epidermis)	Normal
Epidermolysis (Excessive formation of blisters)	Normal
Hypotrichosis (Hairlessness associated with lack of teeth)	Normal
KIDNEYS:	
Diabetes insipidus	Normal
Diabetes mellitus	Normal
Normal	Alkaptonuria (Urine dark after oxidation)
NERVOUS SYSTEM:	
Normal	Multiple Sclerosis (Diffuse degeneration of nerve tissue)
Normal	Friedrich's Disease (Degeneration of upper part of spinal cord)
Normal	Meniere's Disease (Dizziness and roaring in ears)
Normal	Chorea (St. Vitus Dance)
Normal	Thomsen's Disease (Lack of Muscular tone)
Huntington's Chorea	Normal
Muscular Atrophy	Normal
EYES:	
Pigmentary Degeneration of Retina	Normal
Glaucoma (Internal pressure and swelling of eyeball)	Normal
Coloboma (Open suture in iris)	Normal
Displaced lens	Normal
EARS:	
Normal	Deaf-mutism
Normal	Otosclerosis (Thickened tympanus with hardness of hearing)

(*Sex-Linked Characters*)

Recessive characters, appearing in male when *simplex,* in female only when *duplex.*

Normal	Gower's Muscular Atrophy
Normal	Haemophilia (Slow clotting of blood)
Normal	Color Blindness (Daltonism; inability to distinguish red from green)
Normal	Night Blindness (Inability to see by faint light)
Normal	Neuritis Optica (Progressive atrophy of optic nerve)

It is believed by some investigators that many other characteristics relating to normal variations of the hair, eye, skin, countenance, temperament, intellect and nervous system are inherited in Mendelian fashion. It is difficult to secure evidence in human heredity and the way in which many of these characteristics are inherited is still in doubt.

Mentality and Heredity.—The importance of good heredity has long been realized in characteristics or combinations of characteristics where the Mendelian principle is not present or where it has been impossible to demonstrate it. A case in point is the inheritance of mental equipment. Mental ability is without doubt inherited as there is a high correlation between the mentality of fathers and sons, and between the mentality of brothers. There is also a high correlation between the mental abilities of husbands and wives since there is usually selective mating through which men choose wives like themselves in mentality. (In contradiction to a popular belief most people marry "likes" not opposites.) This helps to raise the father and son correlation.

The inheritance of mentality is not like the inheritance of a dominant or recessive unit character. In mentality, phys-

ical stature, size and some other characteristics the offspring of widely different parents seems to be intermediate between the two. It would seem that there is either a blending of characteristics or else the quality in question is produced by many or "multiple" unit factors. In the latter case if the father possessed twenty factors for mental ability and the mother ten the offspring would receive about fifteen and would therefore be intermediate in condition thus giving the appearance of "blending inheritance."

Of course the question of environment enters here since children of most brilliant parents would have the best surroundings. It is not possible to give a general answer to the question as to which is the *more* important, heredity or environment. Color blindness is due to heredity; voice, speech, manners and indeed business success may be due to environment. There is good evidence of the importance of heredity, however, in the production of essential mental and physical traits like long life and good constitution. For example, Dr. F. A. Woods has shown that the correlation between father and son in attaining distinction is as high in America as in the old countries of Europe. Now if success were entirely a matter of environment or "equal chance" there would be a lower correlation in America where, as in a young country, the opportunities are much more nearly equal than in the old countries with established castes. The "little red school house" *cannot* "give every boy an equal chance to be president." All men may be "created free" but they are not all "created equal."

Dr. Woods has shown that if the people in the Hall of Fame on the Hudson were stood in line with the first beneath the center of the dome in the capitol at Washington the line made by the thirty would not reach outside the room. If the people of distinction as recorded in standard biographical dictionaries were stood behind them the line would reach outside the capitol and be continued for a mile or so down Pennsylvania Ave. If their contemporaries (the remainder of the American

people) were stood in line behind them the line would stretch to Chicago, on to San Francisco and up to Alaska. Of the last group one in 500 would be closely related to a man of distinction, of the middle group one in four would have a near relative of distinction and of the first group the people would average one such near relative apiece. Apparently there are "good strains" of human stock. (For further evidence the reader is referred to the recent and delightful book on *Applied Eugenics,* by Poponoe and Johnson.)

We have the story of the family of the illustrious Jonathan Edwards which shows innumerable examples of the highest intellectual and moral worth among its descendants. On the other hand we have the story of the Jukes family investigated by Dugdale and concerning which we find the following statistics. In five generations of the descendants of a worthless fisherman there were 1200 persons, including 200 who married into the family; the history of 1040 of these people is partly known or well known. About 300 died in infancy, of those remaining 7 were murderers, 60 were habitual thieves, 130 were convicted criminals, 140 were physically wrecked by their own diseases and wickedness, more than half of the women were prostitutes, and 310 were professional paupers living in almshouses a total of 2300 years, not one of these people had a common school education and only 20 learned a trade, 10 of whom learned it in a state prison. Here of course it is not easy to separate heredity and environment.

Perhaps a somewhat more striking example of the importance of heredity is to be found in the story of the "Kallikak" family which has been cited by Dr. Henry Goddard (*The Kallikak Family, a Study in Heredity and Feeble-mindedness*). Here is the story of a revolutionary soldier who took advantage of a feeble-minded girl. From this indulgence a feeble-minded son was born, from him there descended a long line of degenerates, similar to those we have just described among the Jukes family. After the war, Kallikak, who was of good English descent, married a Quaker girl of good ancestry

and from this legitimate union a long line of descendants has been traced, all of whom held position in the upper walks of life and none of whom were criminals or ne'er-do-wells.

Feeble-mindedness.—The normal individual must accept his responsibility for race betterment in deciding the question of marriage, but the problem involved in preventing the propagation of the mentally deficient is one which society must handle. These feeble-minded people are divided into three groups according to mentality. The *idiot* has a mental age no greater than that of a normal child of two years, among *imbeciles* the mental age remains at about that of the four year period, while the *moron* has a mental age not greater than that of a twelve year old child.

None of the four measures, which have been proposed for controlling the propagation of defectives is fully satisfactory. These measures are (1) education, (2) legislation, (3) segregation, and (4) surgery. *Education* of the general public may make society more alert to this problem for it is certainly startling when we realize that America has about half a million insane, feeble-minded, epileptic, blind and deaf; 80,000 prisoners, and 100,000 paupers, who are supported at a cost well over a hundred million dollars a year. *Laws* limiting the marriage of feeble-minded people have been enacted in many states. *Segregation* is an ideal procedure where it can be applied but it is hopeless to attempt to secure all the afflicted and to place them in segregation hospitals. Resorting to *surgery,* the simple operation of severing the vas deferens or the slightly more complicated operation of severing the Fallopian tube, has been practiced but there is a serious danger from the misuse of this surgical measure and a practical difficulty in determining where it shall be applied.

Heredity and Conduct.—A somewhat different phase of the Hygiene of Reproduction concerns a question which is naturally and often asked, namely, what effect will one's habits, virtues, and vices have upon the offspring. The present theory regarding the inheritance of acquired characteristics

is indicated in the surgical experiment of Dr. W. E. Castle in which the ovaries from a small black guinea pig were transplanted into an albino (pure white) guinea pig, which was later mated with another albino. The offspring produced were black. This experiment shows that the hereditary qualities lay in the germ cells and not the body as a whole.

We know also that embryologically the sex cells are early separated from the rest of the body and that the ova themselves are already formed in full number at the time of birth. Mutilation experiments, like cutting off the tails of mice for several generations, have failed to show any shortening effect in inherited character.

One may say that, from the standpoint of the race, the germ cell is of greater importance than the individual. This in general is true, for a person is like the father merely because he is decended from the same line of similar germ cells. The children of soldiers mutilated in war will be normal in every respect so far as the influence of these mutilations is concerned. An injury to the germ cells is much more serious than an injury to the body tissues of the individual.

The number of cells of the body which, through one's descendants, may outlive the span of his own life is determined by the number of his children. We cannot change the hereditary characteristics which are embodied in these cells, but we should remember that these cells are a living part of the body and that they are subject to some of the same influences which injure other tissues. We would expect to find the greatest vitality in those cells which are in a normal and healthy body.

Certain poisons, which are distributed through the circulation, can reach these cells and a poison which is capable of serious injury to the growing or adult organism may thus be expected to reach in its baleful influences to the unfertilized sex cell. Lead is such a poison. When it gradually accumulates in the system it not only injures the body of the parent

but it injures the germ cells as well. When there is serious lead poisoning in either the father or the mother the number of still-born children is greatly increased and those who do live are often of inferior vitality.

The poison from syphilis is a substance which has most harmful effects especially upon the nervous system of children. This disease, moreover, as we shall see later, may be inherited in the active and contagious form. Gonorrhea is not inherited but there is danger of infection of the child at birth and the deleterious effects upon the sex organs of the parent may be serious. The case against alcohol is not as clear for the evidence of physical or mental inferiority in the children of alcoholics is conflicting. Possibly none of these substances are true race poisons as the offspring which *do* survive do not appear to pass on the defects to the next generation. But certainly a belief in the noninheritance of acquired characteristics is not an argument for intemperance and incontinence.

One may ask, however, whether this does not end the parental obligation to exercise proper control over the temper and the nervous system generally. The answer would be that faulty hygiene in these respects will injuriously affect the general vitality of the individual and, what is more important, the environment of the children. Furthermore if the individual is a confirmed neurasthenic perhaps he ought to consider the inadvisibility of rearing children.

PRENATAL CARE

But it is not enough that a child should have a good inheritance; if it is to be well born it must live under proper conditions during the fetal period and if it is to start life without physical handicaps it must be given special and proper care during its early infancy and childhood. The great need is that mothers should realize that childbirth is an exceedingly important affair which involves the future health of two individuals and that the expectant mother should

early realize her condition and seek the advice of the best physician available.* In many centers of population the health departments carry out a proper function in providing health centers where advice upon these subjects can be secured. The physician has no cause to object to this arrangement since the woman who is able to pay for the services of her own physician will prefer to do so, and certainly physicians are willing to let someone else take care of their charity cases or prepare such cases for delivery.

We may enumerate some of the reasons why it is important for the prospective mother to consult her physician or one of the health centers when, by the absence of menstruation or other signs of pregnancy, she realizes her condition. She should know that the heavy tax upon the system and the extreme muscular energy required at childbirth make it in reality "an athletic event" and she must begin training for this, the most important event in her life. She should have a thorough physical examination to see whether there are any organic defects. This should include an examination of the heart, the urine, lungs, and blood. Many bodily defects, if discovered at this time, can be corrected before childbirth and perhaps the life of both mother and infant saved thereby.

The teeth should be given careful examination because their decay during pregnancy is extremely rapid. For this decay two probable causes have been suggested; the use of calcium salts in building bone tissue for the infant and the probable increase in acidity in the mouth of the expectant mother. Repair work should put the teeth in perfect condition early in pregnancy and they should be given daily attention.

If it is the first pregnancy the physician who is to take care of the case will also measure the pelvis to see whether there is danger of obstruction to labor because of the small size or ab-

*Literature on prenatal hygiene can be secured from any State Department of Health or from the U. S. Public Health Service.

normal shape of the pelvic canal. He will also be on the watch for albuminuria and eclampsia, and will require the patient to submit a sample of urine at least once a month. The latter condition which in its later manifestations produces convulsions and unconsciousness may be largely avoided, even among women bearing the first child, by early detection and proper hygiene. Patent medicines advertised to make childbirth safe, easy and painless are frauds, and cannot be substituted for the services of a physician.

The woman should realize that a double burden is placed upon her vitality. She must eat for the child and excrete the waste products produced by the metabolism of its body. It is probably the presence of some of these waste products which causes morning sickness with other systemic disturbances. Following is a list of directions prepared by Dr. Austin Brandt, a prominent obstetrician of Boston, for the use of his patients.

DIRECTIONS DURING PREGNANCY

Be careful to bring or send a clean specimen of the urine every week. Have your name and address on the bottle. Even if feeling perfectly well, come to the office at least once a month.

If possible, drink each day six glasses of water between meals—one the first thing in the morning—two during the forenoon; two during the afternoon; and one just before retiring.

Be careful to have the bowels move regularly each day; and report any inability in this direction.

Keep the skin healthy by frequent bathing. Use only the shower bath during the last three weeks.

For exercise, walking is the best. Walk from one to two miles each day. Avoid lawn-tennis, horseback riding, and fast or rough motoring.

Bathe the nipples night and morning with the solution prescribed.

Wear loose clothing, capable of being adjusted to the increasing size of the abdomen. There is no objection to loose fitting corsets. Do not wear circular garters.

Report headache, vomiting (especially after the middle of pregnancy); any marked swelling of limbs or face; any disturbance of vision; any bleeding or escape of water; any pain with regular recurrences.

Standards for Maternity Care.—The responsibility of the community or the state in providing the proper facilities for suitable maternity care is set forth in the following list of requirements prepared by the Children's Bureau of the U. S. Department of Labor as part of a set of minimum standards for child welfare.

MATERNITY

1. Maternity or prenatal centers, sufficient to provide for all cases not receiving prenatal supervision from private physicians. The work of such a center should include:

(a) Complete physical examination by physician as early in pregnancy as possible, including pelvic measurements, examination of heart, lungs, abdomen, and urine, and the taking of blood pressure; internal examination before seventh month in primipara; examination of urine every four weeks during early months, at least every two weeks after six months, and more frequently if indicated; Wassermann test whenever possible, especially when indicated by symptoms.

(b) Instruction in hygiene of maternity and supervision throughout pregnancy, through at least monthly visits to maternity centers until end of sixth month, and every two weeks thereafter. Literature to be given mother to acquaint her with the principles of infant hygiene.

(c) Employment of sufficient number of public-health nurses to do home visiting and to give instruction to expectant mothers in hygiene of pregnancy and early infancy; to make visits and to care for patient in puerperium; and to see that every infant is referred to a children's health center.

(d) Confinement at home by a physician or a properly trained and qualified attendant, or in a hospital.

(e) Nursing service at home at the time of confinement and during the lying-in period, or hospital care.

(f) Daily visits for five days, and at least two other visits during second week by physician or nurse from maternity center.

(g) At least ten days' rest in bed after a normal delivery, with sufficient household service for four to six weeks to allow mother to recuperate.

(h) Examination by physician six weeks after delivery before discharging patient.

(Where these centers have not yet been established, or where their immediate establishment is impracticable, as many as possible of these provisions here enumerated should be carried out by the community nurse, under the direction of the health officer or local physician.)

2. Clinics, such as dental clinics and venereal clinics, for needed treatment during pregnancy.

3. Maternity hospitals, or maternity wards in general hospitals, sufficient to provide care in all complicated cases and for all women wishing hospital care; free or part-payment obstetrical care to be provided in every necessitous case at home or in a hospital.

4. All midwives to be required by law to show adequate training, and to be licensed and supervised.

5. Adequate income to allow the mother to remain in the home through the nursing period.

6. Education of general public as to problems presented by maternal and infant mortality and their solution.

Statistics show the importance of better maternity care. The United States ranks fourteenth in a list of sixteen leading countries in its rate of maternal mortality. To quote from a special report of the Children's Bureau:

Out of the 16,000 women who die (annually at childbirth) about 7,500 die from diseases which are now to a great extent preventable or curable.

In 1913 childbirth caused more deaths among women 15 to 44 years old than any other disease except tuberculosis; it caused in the same year among the same age group between three and four times as many deaths as typhoid fever.

During the 13 years from 1900 to 1913 the typhoid rate has been cut in half, the tuberculosis rate markedly reduced, the diphtheria rate reduced more than one-half. In other countries there has been a decrease in the death rate from childbirth, but in the United States * * * the new figures now published by the Census Bureau for the year 1916 (16.3 per 100,000 population) indicated that since 1900 no decrease in maternal deaths had yet taken place. And physicians remind us that the women who die in childbirth are few beside those who suffer preventable illness or a lifelong impairment of health.

The loss involved is immeasurable. It does not stop with the loss of vigor and efficiency in the mother. It extends, in general, to the well-being of her children; and in particular to the motherless infant who faces a peculiarly hazardous existence. For example, in two of the cities included by the Children's Bureau in its study of infant mortality, the mortality rate among babies whose mothers died during the year following birth is compared with the rate for all the babies in the city. In Waterbury the rate among the motherless babies

is three times the average for the city; in Baltimore, five times the average for the city.

Our enemies are chiefly ignorance and poverty—from a community point of view perhaps mostly ignorance.

INFANT CARE

The birth and the early days of infant life should represent the important culmination of all these weeks of care and it goes without saying that the best obstetrical services should be secured and that the mother should be given an opportunity to rest after this ordeal. During the prenatal period and the early days of infancy the district or public health nurse is an invaluable asset to the community and her activities under a properly managed health department have always shown a saving of mother and infant lives.

It is exceedingly important that the mother should learn from her physician, from the health center or from literature on infant hygiene, the essentials in caring for her baby. She should know that four bottle-fed babies die to one that is fed by its mother and that apart from the greater danger of disease in artificial feeding, there is surely greater strength and vitality among babies who are breast-fed. She should eat only foods which agree with her or otherwise the quality of her milk may change; and if possible she should avoid weaning the baby in the hottest weather when intestinal diseases among children are most common. The baby's clothing should not be too warm or too tight. It needs fresh air and rest and not continual movement by being tossed in the air. The house must be kept clean. The daily bath should be properly administered; during the first three months the water should be about body temperature.

All these and many other things are highly important to the welfare of the infant and are mentioned here only to reinforce the statement that the importance of childbirth demands that the mother should properly inform herself through

the aid of her physician or the organized health department of her state or city.

The following quotation from a pamphlet on *Breast Feeding Her Baby* in the "Keep Well Series" of pamphlets issued by the U. S. Public Health Service, is an example of the excellent, concise and specific health literature available from government agencies.

Of every 100 bottle-fed babies 25 die in the first year of life; of every 100 breast-fed babies only 6 die in the first year of life.

Nearly every mother can nurse her baby during the first three or four months of its life, and if she can nurse it for ten months so much the better.

There may be an abundant supply of milk after the first few weeks, even if there is but little at first; the act of nursing causes the milk to come into the breasts and increases the supply. It is very important that the baby nurse regularly.

In case the baby is not getting enough milk, the quantity lacking should be made up by properly prepared, safe cow's milk. Let a physician decide this. There may be only a temporary shortage on the mother's part, and with suitable care the milk will probably increase so that the breast supply will eventually become sufficient.

Peace of mind is necessary for the nursing mother; she should have no worries; she should not get overtired. She should eat freely of her customary diet. The total quantity of fluids taken by her in 24 hours should not be less than 2 quarts; more in hot weather. Stuffing, however, is unnecessary and undesirable.

Tuberculosis in the mother is practically the only disease that always forbids nursing. Paleness, nervousness, fatigue, pains in the back and chest, or the return of the monthly sickness are not sufficient reasons for weaning, but when these symptoms are present or pregnancy ensues a physician should be consulted at once.

Shortly after birth, boiled water, without sugar, may be given to the baby at regular intervals until the mother's milk supply is established. The baby, however, should be put to the breast at stated times, as often as the mother's condition permits.

It is always wise to make nursing as easy as possible for the mother and to give her opportunities for rest. Therefore, the sooner the baby is satisfied and gaining on three-hour or even four-hour intervals the better.

Convenient hours for nursing the baby are as follows:

1. Seven nursings in 24 hours.—6 a. m., 12 noon, 3 p. m., 6 p. m., 8 or 10 p. m., and once during the night.

2. Six nursings in 24 hours.—6 a. m., 9 a. m., 12 noon, 3 p. m., 6 p. m., and at the mother's bedtime; or at 6 a. m., 10 a. m., 2 p. m., 6 p. m., 10 p. m., and one during the night.

3. Five nursings in 24 hours.—6 a. m., 10 a. m., 2 p. m., 6 p. m., 10 p. m., or later.

The baby should be offered cooled boiled water between feedings, especially during hot weather.

The length of time for a nursing varies with the infant and with the breast. The average infant rarely nurses longer than fifteen minutes. The important point is to satisfy the baby. If there is any doubt, let it nurse longer, but not more than twenty minutes. If it is not satisfied after twenty minutes, consult a physician.

It is customary to nurse only with one breast at each feeding, and to use them alternately. If, however, the baby does not get enough from one breast, give it both.

It is important to keep the nipples clean; they should be washed before each nursing. Caked breast, or cracked nipples, although they may be harmful to the mother, do not make the milk poisonous for the baby. In both instances consult a physician, for a breast abscess may result if the condition is not attended to. The baby should usually be completely weaned at the end of the first year. Up to this time breast milk should be given to the baby as long as it thrives. It is better, when possible, to continue nursing through the summer and to wean in the fall, but if the year has not been completed in the spring, it is better to wean in the summer than in the spring.

Do not wean the baby suddenly; it should be done gradually by replacing one breast feeding at a time with a bottle feeding. Several weeks are required for weaning.

It is dangerous to wean a young baby. It should not be done for the convenience of the mother and should never be done without the advice of a physician.

When the mother's milk is diminishing it is advisable to make up the lack with properly modified cow's milk. This may be done either by following one or more breast feedings with enough modified milk to satisfy the baby or by giving one or more full bottle feedings in place of a like number of breast feedings.

The flow of breast milk tends to diminish when the baby nurses less than five times in 24 hours. When the baby is being nursed once every four hours and is not satisfied it is better to replace a nursing with the bottle. If, however, shorter intervals and more feedings are being used, a bottle feeding may take the place of a nursing without so much danger of decreasing the supply of breast milk. Most babies need additional food after the seventh month.

The Obligation of the Community to the Infant and the Preschool Child.—The statistics of 1916 show that more than 75,000 babies in the United States died before they had completed their first month of life. From the latest available statistics the average number of deaths under one year of age per thousand births in the United States is 94. But there is ample room for improvement as shown by comparing this figure with the following rates for other countries: New Zealand, 48; Australia, 56; Norway, 68; Sweden, 70; Switzerland, 78; The Netherlands, 85; Ireland, 88; Denmark, 95; England and Wales, 96; Scotland, 107.

England showed us what it is possible to do by actually reducing the infant mortality rate to the lowest point in her history while the world war was being carried on. This was accomplished by providing for the compulsory notification of births within thirty-six hours, government aid for local maternity and infant welfare work amounting to not more than 50 per cent of the approved expenditure, publicity explaining the government plan with its details for antenatal, natal, and postnatal work, and a great increase in the number of health visitors. The number of these visitors was increased from 600 in 1914 to 1,024 in 1917 and the Board recommends that there should be one to every 400 births. The number of welfare centers in England and Wales increased from 850 in 1917 to 1278 in 1918.

The duty of our own communities is set forth by the Children's Bureau in the following set of standards for Child Welfare relating to infants and preschool children.

1. Complete birth registration by adequate legislation requiring reporting within three days after birth.

2. Prevention of infantile blindness by making and enforcing adequate laws for treatment of eyes of every infant at birth and supervision of all positive cases.

3. Sufficient number of children's health centers to give health instruction under medical supervision for all infants and children not under the care of a private physician, and to give instruction in breast feeding and in care and feeding of children to mothers, at least once

a month throughout the first year, and at regular intervals throughout preschool age. This center to include a nutrition and dental clinic.

4. Children's health center to provide or to cooperate with sufficient number of public-health nurses to make home visits to all infants and children of preschool age needing care—one public-health nurse for average general population of 2,000. Visits to the home are for the purpose of instructing the mother in—

(a) Value of breast feeding.

(b) Technic of nursing.

(c) Technic of bath, sleep, clothing, ventilation, and general care of the baby, with demonstrations.

(d) Preparation and technic of artificial feeding.

(e) Dietary essentials and selection of food for the infant and for older children.

(f) Prevention of disease in children.

5. Dental clinics; eye, ear, nose, and throat clinics; venereal and other clinics for the treatment of defects and disease.

6. Children's hospitals, or beds in general hospitals, or provision for medical and nursing care at home, sufficient to care for all sick infants and young children.

7. State licensing and supervision of child-caring institutions or homes in which infants or young children are cared for.

8. General educational work in prevention of communicable disease and in hygiene and feeding of infants and young children.

SEX HYGIENE

A properly arranged sex life cannot be insured by preaching fear and the consequences of immorality, but certainly the proper basis for a normal sex life in the developing child is adequate knowledge. The old-style false modesty and innocence has been shown in many cases to be not only useless but dangerous and pernicious.

Sex Education.—Instruction in sex hygiene may be divided into three parts. Beginning at the age of three years the child is likely to ask questions as to whence it came. It should be given a truthful answer to its questions but no more. Old stories about the stork are not to be used, but on the other hand, this is not the time and place to teach sex hygiene and prophylaxis. This inquisitiveness dies out to a large ex-

tent at about the age of five. By this time the child should learn that questions concerning these subjects are to be brought to the parent.

The second stage of instruction is just before the age of puberty—twelfth to fourteenth years. At this time the child should be given certain information about the changes which it is soon to undergo. The instruction should be brief, personal, and individual. This is a task for the parent, doctor, or friend, but not for the public school. The story is brief and can be told in a few minutes. It should not fire the imagination but should warn against abuse and explain how it is that continence is entirely compatible with health. Such instruction cements the friendship of the child.

The third stage of instruction is to be given to young men and women at the age of sixteen to eighteen years, and concerns chiefly information regarding the venereal peril. Such a book as *The Three Gifts of Life* by Nellie M. Smith (Dodd, Mead & Co., New York, 1918) presents the story of sex to girls in a splendid and interesting way and may well be used to precede such a talk. Here again high school biology is not the place for the subject to be taught.

Fear alone is not a deterrent, but an actual knowledge of the dangers in the path and a true picture of the beauty of virtue, appealing to the boy's love for sister and mother with a consideration of the obligations to the future wife, will go far to pave the way for proper living. We may deplore the double standard of morals, but in changing it, we must see that the boy accepts the standard of the girl and that we preach equal restraint, not equal liberty, for belief in the chastity of women is a most important restraining influence in the boy and young man. It is hardly necessary to add that a vigorous physical life, helpful social surroundings and abstinence from alcohol are most important factors.

The third stage of sex instruction has recently been made much easier by the activities of the Federal and State departments of health which have established special bureaus for the

control of venereal diseases and have made available moving pictures and pamphlets for information on this subject. The motion pictures prepared and shown under the auspices of the government and preceded by a medical talk from an official of the health department are very helpful. The boy or girl between fifteen and nineteen however should be accompanied to these pictures by the proper parent. It is certainly undesirable that these pictures should be shown for profit and without proper supervision and accompanying medical instruction, for then the mind of the boy or girl is centered upon the suggestive elements and not upon the medical facts. Public sentiment shoud prevent the improper use of these films.

Summary.—In *The Child's Ten Commandments to Parents,* written some time ago for the *American Journal of Public Health,* I have summarized many of the obligations mentioned above:

The Child's Ten Commandments To Parents

And a new voice said to the people,

I am the generation yet unborn who by being well born and properly cared for shall lead the race out of the bondage of disease to a healthier, better, and happier life.

Thou shalt have no temporal gods before me.

Thou shalt not bow down thyself before false images of temporal pleasures or become bound by overwork or by intemperance in thy food, thy drink, or thy habits, for thy God is a righteous God and visiteth these sins in the form of physical weakness upon thy children.

Thou shalt not take my name in vain or think lightly of me in thy younger days for thou must begin when a boy or girl to prepare for my coming, by building a strong body and keeping it free from harmful substances and the taint of disease.

Remember the pre-natal days and keep them properly. Other days shalt thou do hard labor if need be, but these are

the months that are mine, and thou shalt seek advice of thy physician and so conduct thy life and that of thy family that I may become strong and not afflicted in these days of my coming.

Honor thy sons and thy daughters that our days may be long upon the earth; when we are babes give us the food which nature intended us to have and see that such hygienic measures prevail in thy house and in the community where thou livest that we shall not be menaced by disease.

Thou shalt not kill our confidence in thee by telling us lies about ourselves, and when at an early age we begin to ask from whence we came, thou shalt answer the questions truthfully and volunteer no further information.

Thou shalt not make it easy for us to commit sexual excesses by neglecting to tell us at the time of puberty what changes are to come upon our physical beings, and at the time of early manhood or womanhood thou or thy trusted friend shall explain to us individually the nature of those diseases which may inflict suffering upon us and upon those we love, explaining also the rules of personal hygiene, which will enable us to avoid all excesses that would make us in our generation unfit for parenthood.

Thou shalt not steal our peace of mind by failing to inform thyself and consult with us frankly upon problems involving the proper development of the body, the mind, or the social and religious conscience.

Thou shalt not bear false witness to what thou wouldst have us believe by leading a life which is unhygienic, empty of serious thought or immoral.

Thou shalt not covet ease for thyself or thy children thereby forgetting the duties of every person as a citizen and a neighbor.

CHAPTER VI

THE NEW SCIENCE OF DISEASE PREVENTION

Communicable Diseases.—Thus far we have considered the normal functioning of the body in the endeavor to point the way toward the normal conduct of life and the avoidance of diseases which arise from some derangement of the body mechanism from within. There is another group of diseases, those which arise from without the body, and a study of death statistics shows that these two groups of diseases are of about equal importance as causes of death. We are now to turn our attention to diseases which are comparable to the troubles with a machine arising from the entrance of foreign bodies. By the recent and rapid development of preventive medicine, preventive sanitation, and preventive hygiene the number of deaths from this group of diseases is being rapidly reduced, and it is here that the greatest opportunity for prevention lies. In the body, as in the machine, it is possible to prevent these injuries arising from without while the results of wear and tear will eventually make themselves felt.

Early Theories of Disease.—It is difficult to realize that our knowledge of the cause of communicable disease does not date back of our own Civil War and that many people now living can distinctly remember the days when germs were unknown. Previous to this time the world had entertained vague notions as to the nature of these maladies, including the early conceptions of primitive man, the doctrines of Hippocrates and later the doctrines of Sydenham.

The tendency of primitive man to personify all natural phenomena led to the earliest conception of disease as the activity of individual demons and according to this *demonic*

theory pain, disease, and death were held to be caused by special evil spirits.

From Hippocrates (460-359 B.C.) came the theory of the four humors which held the essential elements of the body to be phlegm, blood, yellow bile, and black bile and disease to result from the improper balance between these substances. Our vocabulary still bears testimony to this belief when we speak of people of a sanguine, phlegmatic, or melancholy temperament. And this is not surprising since the theories of Hippocrates and his follower Galen dominated medical thought until the 16th century.

We cannot be detained with a discussion of the various advances in thought between this period and the establishing of our present knowledge except to mention the work of Thomas Sydenham (1644-1689) who asserted that "a disease is nothing more than an effort of nature to restore the health of the patient by the elimination of the morbific matter." In his belief in a definite substance, the *materies morbi,* as the cause of the disease, the "English Hippocrates," as Sydenham has been called, took a definite step in advance and foreshadowed the scientific recognition of infective organisms in the classical researches of Pasteur.

Foreshadowings of the Present Theory.—Certain other scientific developments preceded the work of Pasteur. Most important was the development of the compound microscope about 1835. This was a necessary prerequisite to the study of infectious disease, as well as to the development of cytological and histological knowledge. In 1837 the Italian investigator, Bassi, discovered that a contagious disease of silk worms known as *muscardine* was caused by a parasitic fungus and only two years later (1839) Schoenlein showed another of these mold-like plants to be the cause of *favus* or honeycomb of the human scalp. Here then we received definite information of a parasitic plant as the cause of a human disease.

Fermentation and Disease.—It was in 1838 that Cagniard de Latour, and Schwann in studying yeast showed that alco-

holic fermentation is caused by a living plant. Their theory that this plant was the real cause of the fermentation process was at first disputed and was only thoroughly and finally established by Louis Pasteur (in 1857-1863) who went still further and showed that the "diseases" of beer and wine (abnormal sour and bitter tastes) were produced by micro-organisms other than ordinary yeast. These had invaded the liquid and interfered with the usual alcoholic fermentation by producing undesirable fermentations of their own.

It could hardly fail to occur to any thoughtful person that if this were true for certain diseases of wine and beer, it might well be true also for certain diseases of animals for if we consider step by step the course of any familiar fermentation and then do the same for any familiar infectious disease, we shall discover between them a remarkable similarity. For this purpose we may take the fermentation of apple juice, or cider, and smallpox. The juice of apples is heremetically sealed and kept from exposure to air by the apple skin. In the making of cider this skin is broken, the juice is pressed out and of course exposed to the air, to dust, to the press, to the sides of the vessel which received it, to the strainer through which it passes, etc. At first, and for some time the juice is sweet, insipid, unfermented, but after some time it is plain that a change is coming over it. This change is called the "working" or active fermentation of the apple juice, and a closer examination will show that it is accompanied by a slight rise of temperature or "heating" (which is a familiar phenomenon in many fermentations), as well as by obvious chemical changes resulting in the evolution of gas and the disappearance of sugar, in place of which alcohol makes its appearance, giving to the whole process the name of "alcoholic fermentation." The fermentation of any particular portion of apple juice, however, is not indefinitely prolonged. On the contrary, after a comparatively short time, the process comes to an end, the evolution of gases ceases, and rest supervenes. Since Pasteur's classical researches we know that what has really happened has been first, the seeding of the apple juice by (wild) yeast; second, the slow growth of this during the quiescent period; third, its active growth and "working" during the time of obvious fermentation; and fourth, its gradual cessation of activity during the final period. In the case of the infectious disease known as smallpox the history is usually as follows. A susceptible patient must first be exposed to the disease, perhaps by contact with a person already affected, perhaps with clothing, letters, food or other materials handled by such

a person. After such exposure there is for a time no marked change; but because the disease has been shown by repeated experience to be nevertheless gradually developing, as judged by the result and certain obscure premonitory symptoms afterward recalled, physicians have unanimously agreed to name this the period of incubation. Sooner or later, headache, malaise, and other troubles appear, the patient becomes seriously ill, a physician is called in, a rise of temperature or fever is discovered, the eruption and other marks of smallpox appear, and the patient is plainly affected by active disease accompanied by every indication of profound disturbance and chemical change. But at last, if death does not supervene, recovery ensues, and the patient gradually becomes free from the disease by which he was temporarily overcome. We may add that the barrel of apple juice can undergo the alcoholic fermentation once only, and that the smallpox patient likewise, as a rule, has the smallpox only once. If now we tabulate side by side and in order, the principal phenomena of an alcoholic fermentation such as that of apple juice, and those of an infectious disease such as smallpox, we shall discover a remarkable similarity between them.

A FERMENTATION (Apple juice)	AN INFECTIOUS DISEASE (Smallpox)
1. Exposure of the juice to air, dust, etc.	1. Exposure of the patient to infection.
2. Repose and then slow change. (Growth of the ferment.)	2. Incubation. (Slow and insidious progress of the disease.)
3. Active fermentation or ''working.'' Evolution of gas bubbles, change of sugar to alcohol. Rise of temperature.	3. Active disease. Eruption, disturbance of the usual functions. Rise of temperature or fever.
4. Gradual cessation of fermentation.	4. Slow convalescence (or death).
5. No further liability to alcoholic fermentation.	5. Immunity to smallpox.

The striking analogy here shown suggests something more. It certainly justifies the suspicion of relationship, and shows well the natural fitness of the term ''zymotic'' (fermentative) for that class of diseases in which an analogy so remarkable is manifest.—*Sedgwick.*

Pasteur.—Just as Pasteur had finished his important studies upon the nature of fermentation in wine and beer, thereby opening for himself a broad and alluring field for

further research, he was urged by the French government to undertake the study of a disease of silkworms. This disease was not only causing an annual loss of 100,000,000 francs in France but it was spreading rapidly to other countries so that it threatened the existence of the silk industry in all parts of the world. Pasteur was at length persuaded to attempt a solution of this problem and during the year 1865-1868 he proved this disease (pebrine) to be caused by a particular germ which could be grown by itself in suitable liquid. He also devised a method by which the eggs could be hatched and the silkworms reared without becoming infected with this disease.

He had now definitely established the fact that certain minute plants (bacteria) were capable of producing particular fermentations or souring processes in beer and wine and that another similar organism was the cause of an infectious disease which had killed so many of the silkworms. These bacteria could be grown by themselves and separated from other organisms in a suitable liquid and would always produce their own particular type of fermentation or disease when put back in the proper place. The foundations for the science of bacteriology and the germ theory of disease were thus securely laid.

Lister.—Development from this point was rapid. Sir Joseph Lister, reflecting upon the significance of these investigations of Pasteur, concluded that many wound diseases were probably infectious and set to work by the use of antiseptic dressings, sprays, etc., to establish his thesis which paved the way for the modern practice of sanitary or aseptic surgery.

Koch and the Development of Bacteriology.—Then came the startling work of Robert Koch in 1875-78 who firmly established the science of Bacteriology by his researches upon anthrax and other diseases and by the adaptation of solid culture media, prepared from gelatin substances, on which bacteria could be readily grown and isolated. In his work with

anthrax or splenic fever, a disease then very common among cattle and sheep, and occasionally attacking human beings, he found, as others had already observed, that there were minute or microscopic rods in the blood of animals which had died from this disease. These minute plants he removed from the tissues and planted in the clear liquid which constituted the aqueous humor of the ox's eye. The organism grew in this liquid from which minute quantities were introduced into fresh aqueous humor several times in succession until only the remote descendants of the plants first used were left. When these were introduced into healthy animals thy produced typical anthrax. In other words the chain of proof had been made complete. A particular germ had been found in animals having a particular disease, it had been isolated and grown by itself in pure cultures, it had been introduced into healthy animals where it produced disease and the death of the animal, after which it could be recovered from the tissues. These four steps are known as Koch's rules for identifying the cause of a disease.

The use of solid media in 1881 was followed by the discovery of the bacillus of tuberculosis in 1882, the discovery of the cholera vibrio in 1883, the bacilli of diphtheria and tetanus (lock-jaw) in 1884 and so on. The long list of diseases for which the causes are now known is evidence of the rapid growth of this field. We find diseases caused by a variety of microorganisms which are different in their appearance, their mode of living, and their effect upon the body. The list of infective organisms includes the round, the rod-shaped, and the spiral type of bacteria, fungous or mold-like plants like that producing honeycomb of the scalp and also animal parasites like those producing malaria and amebic dysentery.

PREVENTIVE MEDICINE

Preventive medicine may be properly limited to those processes by which the individual is so treated as to become immune to particular diseases, in other words, the treatment of

the individual to prevent disease. We must look to Pasteur as the founder of this new science. In beginning his studies on immunity Pasteur had before him the example of smallpox and vaccination which had been developed and successfully applied without knowledge of the germ theory of disease. Let us briefly review this story.

Smallpox and Vaccination.—As early as 1717 Lady Mary Wortley Montagu, the wife of the British ambassador at Constantinople wrote to friends at home of the Turkish custom of "inoculating" against this disease. In this inoculation some "matter" derived from the pustle of a smallpox patient was introduced under the skin of a healthy person. Such an individual by choosing inoculation at a time when in good physical health, had a mild attack of the disease and was immune thereafter. The general adoption throughout Europe of this strenuous method of securing immunity speaks for the horror in which the disease was held. Previous to that time smallpox was the great scourge and destroyer of mankind, hardly one person in a thousand escaped it and so common was it that nearly everyone took the disease while yet a child so that it was regarded as a children's disease.

Then came the wonderful discovery of vaccine by Edward Jenner in 1796. Jenner had been impressed as a student at Sudbury by the remark of a patient, in the person of a dairy maid, who said, "I can not take smallpox because I have had cowpox." Testing this belief in his classical experiments Jenner transferred the vaccine virus from the eruption upon the hand of Sarah Nelms,—a dairy maid who had contracted cowpox from her master's cow by infection through a scratch in the hand,—to the arm of James Phipps, a boy about eight years old. This successful vaccination was followed by exposures to see that it provided a complete immunity against the disease, smallpox.

Vaccination experiments were made elsewhere and in Boston, in 1802, nineteen boys were vaccinated with cowpox in an experiment by the Board of Health. Twelve of these boys

were later inoculated with smallpox with negative results while two unvaccinated boys who were also inoculated with smallpox virus both took the disease. The conclusion of the Board of Health that "cowpox is a complete security against smallpox" we now know to be justified. By vaccination this great scourge has been practically eliminated. Indeed, so rare has it become, that even sensible, though unthinking, people forget the horror of the disease and give ear to those who oppose vaccination in spite of the fact that vaccination is now under almost perfect control and is the only sure prevention for smallpox.

The Immunity in Anthrax and Rabies.—But it remained for Pasteur to develop the principle of immunity and to apply it to other diseases. Applying the principle of germ disease to this phenomenon Pasteur reasoned that if the infectious disease is a struggle between a man and a microbe it is probable that in vaccination for smallpox the struggle is less severe for the patient, because the germs have been weakened or enfeebled through residence in the body of the cow. This suggested that disease germs might be weakened by heat, cold, dilution, starvation, etc., and Pasteur actually produced enfeebled or "attenuated" cultures of anthrax and chicken cholera by these means.

The story of his dramatic public demonstration of the practicability of vaccinating animals against anthrax or splenic fever is one of the most interesting in the history of science. Here he showed that animals which had been vaccinated with attenuated cultures of the bacillus were not subject to the disease after inoculation with virulent germs while animals which had not previously received such a vaccination and had been inoculated with the same virulent germs met death at the hands of the disease.

The experiments began on May 5, 1881, at four kilometers' distance from Melun, on a farm of the commune of Pouilly-le-Fort, belonging to a veterinary doctor M. Rossignol, Secretary-General of the Society of Melun. At the desire of the Society of Agriculture, a goat had been

substituted for one of the twenty-five sheep of the first lot. On the 5th of May they inoculated, by means of the little syringe of Pravaz,—that which is used in all hypodermic injections,—twenty-four sheep, the goat and six cows, with five drops of an attenuated splenic virus.

On May 31 very virulent inoculation was effected. Veterinary doctors, inquisitive people and agriculturists formed a crowd around this little flock. The thirty-one vaccinated subjects awaiting the terrible trial stood side by side with the twenty-five sheep and the four cows, which awaited also their first turn of virulent inoculation. Upon the proposal of a veterinary doctor, who disguised his scepticism under the expressed desire to render the trial more comparative, they inoculated alternately a vaccinated and a nonvaccinated animal. A meeting was then arranged by Pasteur and all other persons present for Thursday, June 2, thus allowing an interval of forty-eight hours after the virulent inoculation.

More than two hundred persons met that day at Melun. The Prefect of Seine-et-Marne, M. Patinot, senators, general counsellors, journalists, a great number of doctors, of veterinary surgeons and farmers, those who believed and those who doubted came, impatient for the result. On their arrival at the farm of Pouilly-le-Fort, they could not repress a shout of admiration. Out of the twenty-five sheep which had not been vaccinated, twenty-one were dead; the goat was also dead; two other sheep were dying, and the last, already smitten, was certain to die that very evening. The nonvaccinated cows all had voluminous swellings at the point of inoculation, behind the shoulder. The fever was intense, and they had no longer, strength to eat. The vaccinated sheep were in full health and gayety. The vaccinated cows showed no tumor; they had not even suffered an elevation of temperature, and they continued to eat quietly.—*Radot.**

Later Pasteur evolved a preventive treatment for Rabies, a disease in which the causative germ was not known. In the "Pasteur treatment" for rabies spinal cords which are known to contain the germs of the disease are removed from infected rabbits and the strength of the virus is reduced by extended periods of drying. Then as now, the treatment was begun by introducing into a patient, which had been bitten by a rabid dog, an emulsion made from cord which had been drying for two weeks. On the following days the emulsion was made up from fresher and fresher spinal cord until that which

**Louis Pasteur: His Life and Labors.* By his son-in-law. From the French by Lady Claud Hamilton. New York, D. Appleton & Company, 1885.

had been dried only two days was administered. If administered first this would have produced rabies and death. The story of the first application of this treatment to a human subject in the successful treatment which Pasteur gave to the Alsatian boy, Joseph Meister, is of absorbing interest. (See Life of Pasteur quoted above.)

In the cases cited above the body became immune or able to combat successfully the virulent germs by first conquering the attenuated or weakened germs of each disease. We may defer for the chapter on Immunity the discussion of the weapons and methods of this struggle because the activities of the germs and the body are complex.

Diphtheria and Antitoxin.—There is one disease, however, which is of special interest because a definite poison (toxin) is secreted by the germ just as the poison alcohol is secreted as a metabolic product of the yeast cell. In diphtheria a toxin is poured out from the bacterial cells which is extremely poisonous to certain cells in the body.

In 1892 Berhing and Kitasato discovered that the blood of an animal which had been made immune to the toxin of diphtheria was able to neutralize or impair the virulence of such a toxin, while the serum of the nonimmune animal could not. They found the poison produced by the bacillus of diphtheria to be soluble and separated it from the germs which produce it. We now secure the antitoxin which has the power to neutralize this poison from the blood of horses which have been made immune by injecting small and increasingly larger doses of toxin. Since this antitoxin may be secured by itself it may be used in treating the disease if introduced into the body of the patient, where it neutralizes the toxins produced by the diphtheria bacilli.

PREVENTIVE SANITATION

We have spoken of the new knowledge of germs as the cause of disease and the development of the principle of immunity, which forms the basis of preventive medicine. The second

great division of this new science of disease prevention is preventive sanitation.

The knowledge that diseases were produced by germs and that the spread of disease is due to the infection of the healthy individual with these living germs makes it clear that for self-protection society must prevent the voiding of germs by the diseased person where they will be picked up by other individuals. The responsibility of society was recognized even before the development of the germ theory of disease was well established, for as early as 1874 there was a belief among experts that "the existence of specific poisons capable of producing cholera and typhoid fever is attested by evidence so abundant and strong as to be practically irresistible. These poisons are contained in the discharges from the bowels of persons suffering from the disease." (Rivers Pollution Commission of 1868, Sixth Report, London, 1874.)

The Epidemic of the Broad Street Well.—One of the foundation stones for this belief was laid in the excellent work of Dr. John Snow of London in 1854, in investigating an epidemic of Asiatic Cholera, which was traced to the water of the Broad Street well. Inasmuch as this was the beginning of the science of epidemiology we may briefly give it our attention.

During the epidemic the death rate in St. James Parish was far higher than that for any other district. Moreover the deaths were unequally distributed and had nearly all taken place in the vicinity of Broad Street. It appeared therefore, that there must be some other factor involved than the usually accredited causes of epidemics, such as meteorological conditions, the general impurity of the air, the nature of the soil and the density of the population. From the beginning of the outbreak Dr. Snow had taken the trouble to get the number and location of all the fatal cases. He found that 83 deaths took place during three days beginning with August 31. To quote from his report:

On proceeding to the spot I found that nearly all the deaths had taken place within a short distance of the pump in Broad Street. There were only ten (10) deaths in houses situated directly nearer to another street pump. In five (5) of these cases the families of deceased persons told me they always sent to the pump in Broad Street, as they preferred the water to that of the pump which was nearer. In three other cases the deceased were children who went to school near the

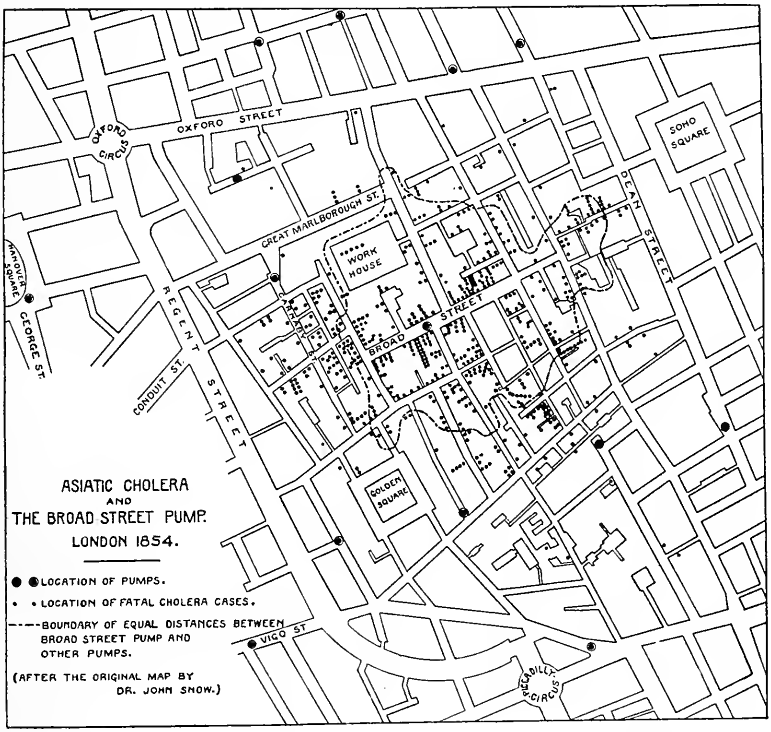


Fig. 19.—Cholera deaths in the epidemic of the Broad Street Well.

pump in Broad Street. Two of them were known to have drunk the water, and the parents of the third think it probable that it did so. The other two deaths beyond the district which the pump supplies represent only the amount of mortality from cholera that was occurring before the eruption took place.

With regard to the 73 deaths occurring in the locality belonging, as it were, to the pump, there were 61 instances in which I was informed

that the deceased persons used to drink water from the pump in Broad Street, either constantly or occasionally. In six (6) instances I could get no information, owing to the death or the departure of every one connected with the deceased individuals; and in six (6) cases I was informed that the deceased persons did not drink the pump water before their illness.

The result of the inquiry consequently was that there had been no particular outbreak or increase of cholera in this part of London, except among the persons who were in the habit of drinking the water of the above-mentioned pump well.

I had an interview with the Board of Guardians of St. James Parish on the evening of Thursday, 7th of September, and represented the above circumstances to them. In consequence of what I said the handle of the pump was removed on the following day.

Among the unusual causes which added confirmation to this belief Dr. Snow describes two as follows:

A gentleman in delicate health was sent for from Brighton to see his brother at No. 6 Poland Street, who was attacked with cholera and died in twelve hours, on the first of September. The gentleman arrived after his brother's death and did not see the body. He only stayed about twenty minutes in the house, where he took a hasty and scanty luncheon of rump steak, taking with it a small tumbler of cold brandy-and-water, the water being from the Broad Street pump. He went to Pentonville and was attacked with cholera on the evening of the following day, September the 2nd, and died the next evening. * * * *

The deaths of Mrs. E—— and her niece, who drank the water from Broad Street at the West End, Hampstead, deserve especially to be noticed. I was informed by Mrs. E—'s son that his mother had not been in the neighborhood of Broad Street for many months. A cart went from Broad Street to West End every day, and it was the custom to take out a large bottle of the water from the pump in Broad Street, as she preferred it. The water was taken out on Thursday, the 31st of August, and she drank of it in the evening and also on Friday. She was seized with cholera on the evening of the latter day, and died on Saturday. A niece who was on a visit to this lady also drank of the water; she returned to her residence, a high and healthy part of Islington, was attacked with cholera, and died also. There was no cholera at this time, either at East End or in the neighborhood where the niece died. Besides these two persons only one servant partook of the water at West End, Hampstead, and she did not suffer, or, at least, not severely. She had diarrhea.

The investigation was further continued by the Rev. H. Whitehead who studied the cause of the sudden pollution of the Broad Street well which he believed must have been the cause of the epidemic referred to above. He found that in house No. 40 Broad Street there had not only been four fatal cases of cholera at the time of the epidemic but there had been earlier cases of an obscure nature which were probably cholera, and that the dejecta from these had been thrown into a cesspool very near the well. Further investigation showed that the bottom of the main drain from this house lay 9 ft. 2 in. above the water level and that one drain was so broken down as to leak like a sieve. Moreover, the poorly constructed cesspool over which a common open privy had been placed connected with the drain. The walls of the cesspool were in the same leaky condition and the removal of the soil showed that there had been a direct drainage from both cesspool and drain into the well. The water had apparently been long polluted but it required a specific infection to produce the outbreak of Asiatic Cholera.

Thus water-born disease was known to exist before it was known that the disease was produced by germs. In other words, at this time it was believed that *filth* produced certain diseases because it produced, harbored and developed certain poisons instead of furnishing, as we now know to be the case, a temporary abode for the germs which have been thrown off from the body of a previous case of the disease.

We might describe other epidemics of intestinal disease which have been traced to polluted water before and after the discovery of the germs of these diseases. To this we could add the story of scores of epidemics of typhoid fever, scarlet fever, and diphtheria, which have been traced to milk and the description of various other methods of infection by means of food or some other intermediate substance.

A Typhoid Fever Epidemic From Oysters.—Perhaps one of the most famous epidemiological investigations on record is that made by Professor H. W. Conn of Wesleyan University

in 1894. In this year there was an outbreak of typhoid fever about October 20 which included over twenty cases among the men of this coeducational college. No common bond was found among the victims of the disease. They boarded at different tables and many lived in private houses in town. The wells of the college campus were excluded on the ground that they were used by town people as well as college students and no typhoid fever had occurred among the townspeople.

Professor Conn's complete and careful studies developed along the lines indicated by the following facts. With three exceptions all the sick men belonged to three fraternities. There were no cases among the women of the college. The water, ice cream, butter and fruit eaten at these fraternity houses were all excluded as sources of the disease because they had been used by other people in the town and college. The study of the dates showed that infection took place about the time of a series of fraternity suppers. One of the cases not belonging to a fraternity had attended such a supper. The menu of these suppers were studied and all foods excluded except raw oysters. It was then found that the women of the college did not hold any special supper on this date and did not eat raw oysters. Of the other four fraternities, among which there were no cases, two did not use oysters at initiation suppers, one obtained them from Hartford instead of Middletown dealers and the fourth used oysters but in the cooked and not the raw state. None of the families in town which bought oysters from this lot had eaten them raw. An attendant who had eaten oysters from this batch in the home of the dealer had had a mild run of the fever. Many alumni and five Yale students were present at the banquet. Among these there were several cases of slight illness, diarrhea, weakness, and four cases of genuine typhoid fever. Two of the five Yale students developed the disease.

The study of the source of the oysters showed that they had been taken from deep water in Long Island Sound, had been brought to the mouth of a creek near Fair Haven,

Connecticut for fattening. Three hundred feet from the beds where the oysters were fattened there existed the outlet from the sewer of a private house in which there were two cases of typhoid fever. The current of water at this point showed that the effluent from this sewer would almost certainly be distributed over the beds in which the oysters were fattened.

These examples of the early and startling discoveries of the transmission of disease from the sick to the well by means of some intermediate substance show the basic principle upon which the science of preventive sanitation has been developed.

The knowledge of germs as the cause of disease, their viability in water, milk, and other foods, and the methods by which they may be destroyed has made it possible to develop scientific means of sewage disposal, water purification, and the protection of food materials. The practical details of applied sanitation in these various fields will be later considered.

PREVENTIVE HYGIENE

Preventive hygiene or the conduct of individuals in such a way as to avoid infection and communicable disease is based upon our knowledge of both preventive medicine and preventive sanitation. Our habits are now influenced by our knowledge of the germs of particular diseases, their mode of life and the manner in which they may be transferred; so that in our daily activities we avoid opportunities for infection. Promiscuous kissing, the use of common drinking cups, and the eating of food prepared and served by people of uncleanly habits whose freedom from infectious disease can not be vouched for; these and many other unhygienic habits are automatically condemned by our knowledge of germ diseases. These dangers of infection will be considered further in our discussion of special diseases.

Resistance.—Preventive hygiene must consider still another feature in resisting infection and particularly in successfully withstanding an infectious disease. Pasteur demonstrated

that the outcome of the battle between man and the microbe may be determined by weakening or attenuating the latter or by building up a specific resistance of the human body. Dr. Theobold Smith has spoken of disease in terms of the formula $D = \frac{NV}{R}$; when D = the disease; N = the number of organisms in the initial infection; V = the virulence of the germs; and R = the resistance of the individual. This resistance in many cases is specific for the disease in question but for other diseases, like Tuberculosis, the resistance may be related to the bodily vigor and general health of the individual. So that personal hygiene, which assists in building up a strong and healthy body, is related to disease prevention and is important in disease as well as in health.

Summary.—We have seen the origin of three united sciences by referring to the history of disease prevention and the discovery of germs as the cause of disease.

Preventive medicine reaches back to the experiments of Pasteur in producing immunity to a specific disease and involves all the more recent developments of this art by the use of specific vaccines, antitoxins, viruses and drugs to assist the person to throw off or withstand infectious diseases. Preventive sanitation rests upon this new knowledge of disease causation and by its application prevents the spread of infection from the sick to the healthy either directly or indirectly through the application of quarantine, the supervision of water, milk, and other food supplies, the purification of sewage, and the prevention of other conditions which would make it possible for live germs to reach and infect healthy individuals. Preventive hygiene recognizes the infectious agents of disease and prescribes for individuals a course of conduct which is best calculated to avoid infection.

CHAPTER VII

ESSENTIAL FACTS OF IMMUNITY

The presence of an immunity is easier to understand than the process by which it is secured. For the ordinary individual the fact is all important but the science of immunology is the foundation of the art of preventive medicine and a brief statement of the essential facts in this rapidly developing science has a place in any extended discussion of the subject of hygiene.

Immunity Defined.—Immunity is a common property of life which may be defined as the power of the organism to resist infection. It is opposite in meaning to the word susceptibility and both these words are relative terms. Immunity may be complete, or so weak as to be hardly appreciable. In many instances we use the term resistance as equivalent to immunity.

Another variable quantity, which is always related to the immunity of the patient, is the virulence of the disease-producing organism. By virulent we mean poisonous or deadly and we find that different strains of germs have varying abilities in their power of evil just as individuals have the varying powers of resistance.

We may illustrate immunity with an analogy from international experience. It is not now difficult for us to conceive of a nation thirsting for world power and opposed to the welfare of the great body of humanity outside that nation. The people of such a country may represent the germs of a disease and the great body of humanity, the person subject to the disease. The individuals of such a nation usually appear innocent enough and, like the germs of disease, quite similar to their harmless neighbors. There finally arises an oppor-

tunity for the invasion of other lands and these people make war upon the rest of the world just as the germs enter into a struggle with the human body. If they are successful the life of the invaded nations comes to an end; if they are not successful in their war they are eliminated from the territory which they have overrun and their armies are reduced in strength and vitality, for the time being, just as the virulence of influenza seems to be reduced after the first severe epidemic. But the other peoples of the world, if they are wise enough to realize the danger from this lust for world conquest, will set up barriers against the return of a world war and if these barriers are strong enough future recurrences may be avoided. These barriers, like the factors of immunity, are varied, numerous and complex. They may consist of a new army to combat the destructive forces of the enemy, of military barriers set up against the entrance of the foe or a general readiness of the peoples to respond immediately to a threat of a new attack. Likewise the human body when attacked by the germs of disease may create new defensive substances which remain in the blood, the tissues subject to microbial invasion may become more resistant to the particular organism or the whole bodily reaction may be more prompt and effective at a second attack.

Our knowledge of immunity has been gained from the observation of diseases and from experimental biology but not from chemistry. In other words, we are not yet able to state the chemical reactions in immunity and disease and we must expand the science by a study of the reactions of experimental animals and the reactions of the immune substances which they produce.

We should recognize at the outset that the resistance of an individual to disease is determined by two factors, his general bodily health or vigor and the presence or absence of specific immune substances in the blood. These two factors are not of the same relative importance in all diseases. In cases of tuberculosis, pneumonia and colds or in cases of sepsis, bodily

vigor is very important. In most of the contagious diseases such as scarlet fever, small pox, typhoid fever, and measles, however, general good health is of little importance in withstanding the infection and immunity can only be secured through the presence of immune substances in the body. It may be that the importance of bodily vigor in combating tuberculosis, colds and other respiratory diseases, is related to the important part played by the living cells (phagocytes). Although the diseases in this group are not numerous they are very important and we may do well to begin by enumerating some of the most important factors in destroying immunity through the reduction of bodily vigor.

NONSPECIFIC IMMUNITY

The things which most frequently break down the nonspecific immunity or general vitality are the following:

1. Fatigue.—Experimentally it has been found that white rats are more susceptible to anthrax after being worked in a revolving cage; and it has also been found that the defensive powers of dogs, rabbits and guinea pigs against typhoid are reduced by excessive exercise. It is hard to explain how fatigue produces these results unless we accept the suggestion that katabolic products of muscular activity are injurious to the cells, especially the white blood cells which, as we shall see later, play an important part in immunity. It is known that these products are acid and that some of the protective substances in the body (alexins and opsonins) act best in an alkaline medium.

2. Exposure to Wet and Cold.—Exposure to wet and cold reduces the power of resistance to disease, as has been demonstrated in the case of fowls which are naturally immune to anthrax but contract the disease after standing some time in cold water. We know that such exposure cools the blood and must therefore reduce the activity of the leukocytes. It may also reduce the production of defensive substances in the

body. This relation to temperature would explain how muscular exercise reduces the danger of diseases under exposure to cold and wet by keeping up the body temperature. Sudden exposure to dampness and cold, especially if the individual had reduced the efficiency of the heat-regulating system of the body through improper clothing and poor ventilation, would produce a lowered resistance in this manner.

3. **Drugs.**—Excesses in the use of drugs and alcohol are well known and important in increasing the susceptibility to tuberculosis. The factors involved here may be the lowering of the temperature, the destruction of delicate defensive substances in the body and the inhibition of leukocyte activity.

5. **Undereating.**—Insufficient and unsuitable food accelerates tuberculosis. This may be explained by the fact that digestion increases leukocytosis. Moreover, infection is more likely to pass through an empty stomach than one where acid digestion is rapidly taking place.

5. **Oral Defects.**—Bacteria which are growing in decaying teeth or in chronically inflamed tonsils are producing poisons which continually tax the protective powers of the body and therefore make it easier for other infective organisms to enter and produce disease. Moreover a dirty mouth, already harboring a variety of bacteria, is a better culture place for disease germs than is a clean mouth. Enlarged tonsils and adenoids reduce the body vigor by their injurious effect upon breathing and nutrition.

SPECIFIC IMMUNITY

Specific immunity exists by virtue of certain substances (immune bodies or antibodies) present in the blood, which prevent or retard the development of the disease in question. It may be natural or acquired, general or local. Acquired immunity may be active or passive.

Natural Immunity.—Certain species of animals are immune to the diseases which affect other species. For example, the

lower animals are immune to many of the communicable diseases of man such as cholera, typhoid fever, mumps, measles, scarlet fever, yellow fever, malaria, leprosy, etc. Man is immune to many of the diseases which attack lower animals. There are certain germs, however, which attack many species of widely different genera. Examples of this group include the organisms of tetanus, malignant edema, anthrax, pus formation, glanders, plague, rabies, Malta fever, foot-and-mouth disease, milk sickness, ringworm, and paratyphoid fever.

Local Immunity.—Many tissues of the body appear to be immune to diseases which do serious damage to other tissues. For example, diphtheria does not often extend from the throat down the esophagus. There may even be a difference in the susceptibility of the same tissue at different periods of life. In general, tissues which are well flushed with blood are relatively immune. Prompt local reaction frequently saves the more remote tissues of the body by holding back the organisms and in general this is a good indication of immunity.

Acquired Immunity.—Acquired immunity is specific for particular diseases and is not inherited. It may be secured by having the disease or artificially induced by the injection of a virus or a vaccine. By *virus* we mean the living organism of infection and by a *bacterial vaccine* the killed organism of the infection. It is obvious that the virus must be reduced in virulence or introduced in very small quantities while the vaccine is less severe and more likely to produce a local reaction followed by a brief general reaction. Sometimes *sensitized vacccines* are produced by mixing the bacteria with the specific antibodies from the blood serum of an animal which has been rendered immune. *Polyvalent vaccines* are made up from several strains of the same organism. *Mixed vaccines* containing the dead bacilli of two or more diseases like typhoid, paratyphoid and cholera are sometimes used. Immunity acquired through the use of vaccines usually lasts from two to five years.

Active and Passive Immunity.—The above description refers to active immunity. In other cases the immunity may be passive or mixed. In diphtheria the horse from which antitoxin is secured is rendered immune to the disease by the injection of increasing doses of diphtheria toxin and his immunity is active. The patient may be made temporarily immune by the injection of immune substances from the blood serum of the horse. This immunity is passive or transferred and is of brief duration. Mixed immunity is produced by injecting immune substances from another animal with the vaccine or toxin as exemplified in the use of plague vaccine with plague antitoxin or in the use of a toxin-antitoxin mixture to immunize against diphtheria.

Carriers.—Usually after a disease the body rids itself entirely of the germs. Occasionally, however, this does not happen and a condition of mutual tolerance is set up. This "immunity without disinfection" is a condition in which the patient continues to be a *carrier* of the germs. The reaction between the patient and the infective organism is not serious. They have acquired the ability of tolerating each other, and the reaction by each has apparently become milder. Carriers are found in diphtheria, typhoid, cholera, epidemic cerebrospinal menengitis, influenza and in certain protozoan diseases like malaria. Many epidemics have been traced to such carriers. There is always a possibility of a spread of the disease in this fashion and in some instances the lowered vitality of the individual may result in a relapse of his own case.

Disease Reactions.—Just as different agricultural plants grow best in different soils, select somewhat different foods, and produce different products, so the germs of disease vary in the part of the body which they attack and differ in their life processes and in the effects they produce upon the individual. The actions and reactions between the various microbes and man are numerous and complex. This is not the place for an extended discussion of them; but they have such an important bearing upon our comprehension of disease and

the terms are so rapidly finding a place in our everyday vocabulary that a brief description of the terminology and phenomena may be found useful to the dental student and practitioner. We shall therefore consider briefly the nature of the struggle waged during the course of an infectious disease.

Toxins.—There are two types of bacterial poisons which produce disease, exotoxins and endotoxins. The true toxin (exotoxin) is defined by Rosenau as "a specific poison elaborated by bacterial metabolism; it is soluble in water; poisonous in minute amounts; reproduces the essential symptoms and lesions of the disease; acts only after a period of incubation; and produces antibodies, namely, antitoxin." Such toxins are complex chemical substances probably belonging to the higher proteins. They are thermolabile and unstable. Three such substances are well known, the toxins produced in diphtheria, tetanus, and botulism. Other bacteria, such as dysentery, pyocyaneus and cholera produce soluble toxic substances which do not, however, have all the above named characteristics.

We should add that many bacteria produce poisonous substances of another type such as ferments, ptomains, acids, alkalis, nitrites and hydrogen sulphid. The bacilli of tuberculosis and glanders form soluble toxic substances which are specific but (in small quantities) harmless in a normal animal, being poisonous only to an animal suffering with the specific disease.

There are also toxins from the higher plants such as ricin from the castor bean and abrin from the jequirity bean. These so-called phytotoxins comply with the above definition of a true toxin in most respects. The venoms produced by wasps, scorpions, spiders, and snakes are very similar substances.

In the case of the true toxin it is impossible to say whether it is a secretion or an excretion or the result of the action of the bacteria upon the medium. There are four important characteristics of these toxins. They are destroyed by boiling or by heating at 63 degrees C. for a short time. They are

extremely poisonous in small quantities (0.000,000,05 of a gram of tetanus toxin is sufficient to kill a mouse). They produce their effect after an incubation period and have a specific combining affinity for particular cells of the body.

Endotoxins.—Certain bacteria contain internal poisons which may be liberated when the bacterial cells die. It is possible to obtain endotoxins by grinding the cells of the dysentery bacillus and the cholera vibrio. We should not conclude, however, that endotoxins are similar in their action and composition to true or *exotoxins*. It may be moreover that the split protein products of the bacteria themselves act as poisons to the body cells.

Reactive Phenomena.—The body has been found to react in definite ways to particular diseases and our knowledge of the basis of immunity rests upon the study of these phenomena which include (1) phagocytosis, (2) anaphylaxis, and (3) the production of specific substances like antitoxins, opsonins, lysins, precipitins, and agglutinins.

1. Phagocytosis. The important work of Metchnikoff in the study of immunity showed that certain bacteria are devoured and digested in great numbers by the cells of the body. Cells which accomplish this task are of two types: the motile cells (white blood cells) and the fixed cells of the connective tissue and endothelium. Metchnikoff believed this phenomenon of phagocytosis to be the principal bodily activity in combating disease and producing immunity.

These cells are susceptible to chemotactic influences and it is conceivable that the attack of a disease might so accelerate their activity that at the inception of a second infection the invading bacteria might be devoured before the disease could be produced. Phagocytosis however is not a complete and adequate explanation for immunity unless it is believed that the phagocytic cells produce special immune bodies—to be considered later.

Opsonins.—Phagocytosis has beeen found to take place only in the presence of certain substances which prepare the bac-

teria for phagocytic digestion. These substances, which are called opsonins, are normally present but may be increased by the injection of bacteria or a specific antigen. They combine with the bacteria and phagocytosis does not take place without them. The opsonic index which is used in vaccine therapy is the measure of these substances as determined by the "avidity" with which phagocytic cells devour the bacteria.

2. ANAPHYLAXIS.—Anaphylaxis or hypersusceptibility is a condition of the body in which it is unusually susceptible to foreign proteins. This is a specific reaction which may be developed against certain bacteria or other protein substances. It may be congenital or acquired, local or general

An example of anaphylaxis as produced by an ordinarily harmless substance is secured by the injection of horse serum into a guinea pig. If the second injection of serum is separated from the first by an interval of eight to fourteen days it produces what is known as acute anaphylactic shock. The guinea pig becomes restless, manifests difficulty in breathing, is generally agitated and discharges both urine and feces. There may soon follow complete paralysis, the arrest of breathing, and death. The guinea pig is apparently much more susceptible to this reaction than any other animal. The explanation of this fact and the phenomenon itself is furnished by Schultz who showed that serum anaphylaxis produces the hypersensitization of smooth muscle tissue which contracts during shock with the fatal results, in the case of the guinea pig, because the mucosal layer of its secondary bronchi is thrown into folds by the contraction of this muscle and breathing is inhibited. This reaction is strictly specific.

By examples of other types of anaphylaxis it may be seen how this increased sensitivity of the tissue to particular germs may produce a very prompt reaction which may be connected with acquired immunity. In the second vaccination for smallpox the incubation period is much shorter and in the prompt "take" the reaction is less severe. It appears in this case

that immunity is not complete but the protection is dependent upon anaphylaxis. In other diseases this prompt reaction may prevent the development of the clinical symptoms.

In guinea pigs such a sensitization may be produced by feeding them meat or serum and the mother guinea pig may transmit a hypersensibility to the toxic action of horse serum to her young. We may raise the question as to whether these facts may not explain why symptoms like those in anaphylactic shock sometimes follow the eating of fish and other articles of diet and whether this phenomenon explains a possible inherited susceptibility to tuberculosis.

The serum sickness, which often takes place from 12 to 14 days after the injection of antitoxic sera and shows symptoms of fever, itching and pain at the point of injection and a general urticaria, may be the anaphylactic reaction from these substances still remaining in the body at the end of the incubation period. The substances which produce serum sickness however are the proteins of the horse serum and not the antitoxin itself.

In considering other examples of anaphylaxis it is to be noted that in most febrile diseases there is a ten to fourteen day incubation period before the general bodily reaction marks the beginning of the active period of disease. Diphtheria or other diseases where soluble toxins are produced obviously do not belong in this class. Tuberculin (a glycerine extract from tubercule bacilli) is not poisonous to a healthy individual but produces a definite reaction in a tuberculous individual because he has become anaphylactic to the disease. This test for hypersusceptibility, therefore, may be used in detecting the disease. It may also be seen that the hypersusceptibility of the tissue produces a prompt reaction which helps to encapsulate the organisms.

It has long been known that in many people fish, tomatoes and cheese are likely to produce an urticarial rash; eggs may produce asthmatic symptoms; and cereals, pork and milk may produce erythemas. These cases and many cases of eczema

may be due to anaphylactic reactions to the special proteins.

Anaphylaxis in hay fever is the hypersusceptibility of the mucous membrane of the respiratory tract to the pollen of ragweed, golden rod and other plants. Dust emanations from horses or other animals or hyperacidity of the gastric juice may produce similar conditions. Puerperal eclampsia, the onset of labor, and the crisis in pneumonia have been in part explained by the phenomena of anaphylaxis.

3. SPECIFIC SUBSTANCES.—*Antitoxins.*—Antitoxins are substances formed in an animal by the stimulation of specific toxins. They are capable of neutralizing the corresponding toxins. They are substances of complex chemical composition, more stable than toxins although destroyed by heat, acids and many other chemicals. These substances appear in the blood and in all the fluids and excretions of the immune animals. When they are introduced into the body, as in the use of diphtheria antitoxin from the horse, they disappear rather quickly, uniting with the toxin or with the body cells but mainly finding exit through the urine, bile and saliva in the form of antitoxin. Passive immunity therefore is transient and lasts usually from ten to fourteen days while active immunity is of much longer duration. Antitoxins are not always produced as a reaction to bacterial toxins even in susceptible animals. A guinea pig which is highly susceptible to diphtheria will not produce any antitoxin.

It can be shown that there is a direct union between antitoxin and toxin by mixing the two in a test tube and then injecting the mixture into a susceptible animal. This injection produces no observable or injurious result. After the toxin has once been united with the body cells however it cannot be dislodged by an antitoxin. It may thus be seen why moderate amounts of diphtheria antitoxin in the earlier stages of the disease are more efficacious than large doses administered at a later period. Antitoxin may be present in the blood before infection takes place.

Agglutinins.—Widal showed that very dilute mixtures of the blood serum of a typhoid patient will cause the typhoid bacilli to agglutinate, that is, to lose their motility and gather in little clumps. These small groups may be seen under the microscope or as flakes in a test tube suspension. It was later found that agglutinating substances may be produced in the blood by injecting dead bacteria into the body, as in typhoid vaccination.

Agglutination does not harm the bacteria by rendering them motionless. They may again multiply and grow vigorously. The so-called germicidal property of freshly drawn milk is probably mainly a phenomenon of agglutination, since the bacteria are clumped together and only one colony for each clump of organisms is developed on the agar plate.

Agglutinins are not absolutely specific since, if they are used in large quantities, closely allied species of bacteria may also be agglutinated. They are however, quantitatively specific, since the corresponding organisms will be agglutinated by a greater dilution. Agglutination may also be produced for red blood corpuscles and protozoa. The part which these substances play in immunity is not yet clear.

Precipitins.—In 1897 Kraus showed that it is possible to produce another type of immune body in the blood serum of an animal by the injection of bacteria or albuminous substances. When the clear serum of an immunized animal was added to the clear antigen the resulting fluid became opaque from the formation of a precipitate which soon settled to the bottom of the test tube. This discovery was made by adding some typhoid serum to a filtered culture of typhoid bacilli. Certain other organisms like cholera and plague produce the same phenomenon but not all bacteria do this and the diphtheria bacillus is the important example of the latter class. This precipitation is similar to the agglutination of bacteria and is a reaction of protein molecules which, as we know, are not true solutions but colloidal suspensions. The relation of these substances to immunity is not clear but we may see how

it may be possible for them to throw down poisons from solution and make them inert.

Lysins.—In 1896 Dr. Pfeiffer observed that when living cholera vibrio were injected into a peritoneal cavity of guinea pigs which had been previously immunized against cholera the germs lost their power of motion, became grouped together in clumps and were finally completely dissolved. This reaction which is specific for special diseases is known as Pfeiffer's phenomenon, and the substances which have the power of disintegrating or dissolving cells or other organized substances introduced into the body are called lysins. Those which disintegrate bacteria are called bacteriolysins, those which dissolve the red blood corpuscles of other animals are called hemolysins, and those which dissolve the cells of glandular tissues are called cytolysins. The normal bacteriolytic properties of the blood are thought to be due almost entirely to a similar nonspecific substance which dissolves the various bacterial cells. It is this power which enables the blood to resist decomposition longer than other animal fluids.

That the complete explanation of immunity is not furnished by the lysins is shown by the fact that animals may be susceptible to disease although the blood possesses bactericidal properties. In anthrax the rabbit is very susceptible although the blood serum is highly bactericidal, while the dog is very resistant although the blood is slightly bactericidal.

Bacteriolysins are distinct from antitoxins and agglutinins. The three substances may be distinguished from one another by proper tests even when they exist together. The lysin is composed of two substances, the immune body which prepares or sensitizes the bacteria and the complement which dissolves the bacteria. The *complement* appears to be formed by the breaking down of leukocytes and is present in normal blood. Although present in the blood it is absent in the aqueous humor of the eye because the latter lacks leukocytes. It is the immune body or *amboceptor* which is specific for particular diseases and which is increased as immunity is built up.

Hemolysis or the laking of blood is the dissolving of hemoglobin from the red blood corpuscles. There are two types of hemolysins: (1) the nonspecific such as distilled water, acids, alkalis and bacterial, plant and animal toxins, and (2) the specific hemolysins which are obtained by treating or immunizing the animal with the red blood corpuscles of another species of animal. Hemolysins of the latter type are similar to bacteriolysins.

It has been stated above that the amboceptor is specific while the complement is nonspecific. The complement fixation test used in the diagnosis of syphilis, gonorrhea, glanders, pertussis, meningitis and other infections is based on this principle.

THEORIES OF IMMUNITY

It should now be apparent that infectious diseases and bodily reactions to these diseases are widely different and that no simple theory of immunity can be satisfactory. It is therefore, only with historical interest that we regard the early theories of Pasteur and Chauveau.

Exhaustion Theory.—In 1888 Pasteur suggested his exhaustion theory which held that immunity was produced because all the food substances were used up. The one fact that bacteria may grow in the dead tissues of immune animals shows that, during the life of the animal, their growth is inhibited by specific substances and not by lack of food.

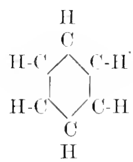
The Retention Theory.—The retention theory of Chauveau maintained that bacterial growth was inhibited in disease by the retention of the products of bacterial metabolism. It is not difficult to demonstrate the fallacy of this view.

Phagocytic Theory.—The work of Metchnikoff in demonstrating the activity of phagocytosis suggested a possible mechanism of immunity. It could be demonstrated that the phagocytic powers of an animal increased directly with its immunity and Metchnikoff asserted that it was the increased activity of the white blood cells which produced immunity.

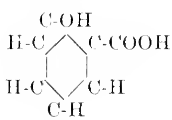
We have seen in the development of opsonins the influence of the body fluids upon phagocytosis.

These views were opposed by Ehrlich and other investigators who believed immunity to be due mainly to substances produced in the body and set free in the body fluids. From their point of view phagocytosis was merely the process of getting rid of bacteria after they had been acted upon by the immune-body substances. Metchnikoff realized the existence of these substances in the body fluids but he believed them to be derived from the leukocytes. The question is by no means settled and there is much evidence to support the great importance of phagocytes in bacterial immunity.

Side Chain Theory.—Every student of organic chemistry is familiar with the term side chain as applied to the atomic groups attached to the benzol ring. The graphic formula for benzene is:



This central structure is possessed by a large number of compounds. For example salicylic acid has the following formula:



The OH and COOH groups are side chains through which other substances and new atomic groups may enter into relationship with the benzol ring.

The side chain theory of immunity, which was developed by Ehrlich, is a theory of chemical side chains which are attached—not to a simple ring as in the benzol group—but to a central atom group of the large and complex proteins which make up cell structures.

In 1885 Ehrlich had stated his belief that the cells of the body take on nutrition through the reaction of side chains, from the central protein molecules, with the various nutritive substances in the circulating blood. It seemed reasonable to him, therefore, that toxin might exert its injurious influence upon the cells of the body by combining with certain chains of the cell protein. Certain of these side-chains might have a specific affinity for a particular poison. When this union had taken place, however, the side chains would be destroyed.

Now it is characteristic of nature to regenerate parts of tissues which are lost and such regenerative processes are almost always carried to excess. A good example of this is seen in the excessive production of bony substance after a fracture. It seemed reasonable that, in this case, nature might produce an excessive number of side chains or receptors under the continued stimulation and if this were done some of them would be thrown off into the blood where they would be free to circulate and unite with the poison before it could reach the sensitive cells. With such a substance (antitoxin) in the blood a new infection would not produce the clinical symptoms of disease and the person would be immune from the disease in question. This type of immunity is spoken of as *immunity of the first order* and is illustrated in the explanatory diagram.

We have seen that the body may possess different kinds of immune reactions as exemplified by the power of blood serum to agglutinate and precipitate such disease germs as those of typhoid fever. The bacterial substance which injures the human body in this case is not a soluble substance, but a complex molecule of the bacterial protoplasm. It seemed to Ehrlich that the immune bodies in this type of reaction must be more complex than the receptors described above. Side chains which are capable of handling these albuminous substances he conceived to have not only a combining (haptophore) group, for anchoring the substance to the body cells, but also a ferment (or zymophore) group which could break down the complex molecule after it was anchored. The agglu-

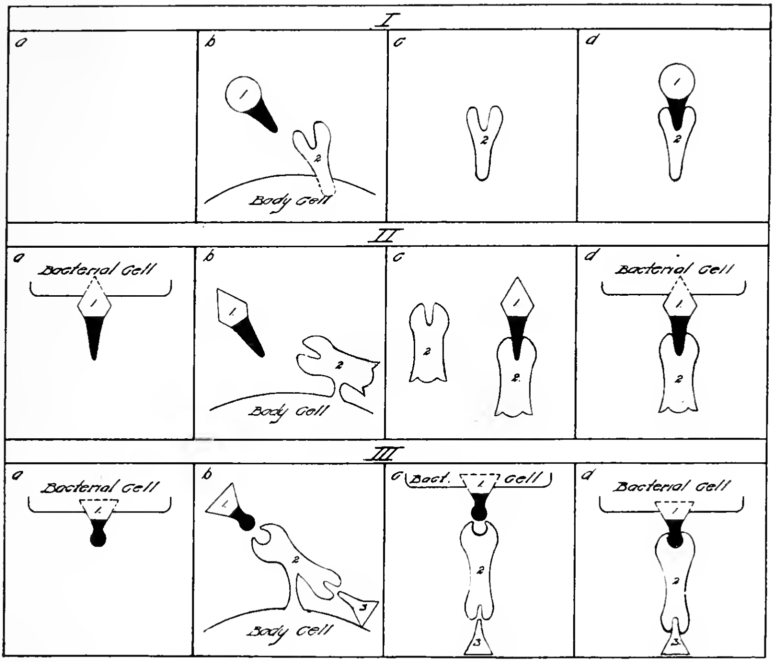


Fig. 20.—Diagram illustrating the three orders of immunity as described in Ehrlich's Side Chain Theory of Immunity.

I. *Immunity of the first order.* 1. Inciting substance (toxin). 2. Immune substance (antitoxin). (b) Shows antitoxin which has been absorbed into the blood stream from the diphtheritic throat. The toxin molecule is seen approaching the side chain. (c) By the excessive production of side chains antitoxin is thrown off into the blood. (d) The antitoxin unites with the toxin in the blood preventing the latter from attacking the living cells.

II. *Immunity of the second order.* 1. Inciting substance (antiagglutinin, antiprecipitin, etc.). 2. Immune substance (agglutinin, precipitin etc.). The immune substance in this case shows a haptophore group (joining end) and a zymophore group (portion containing an enzyme). (a) Bacterial cell with inciting substance in the blood (b) inciting substance about to combine with side chain of body cell. (c) Free antibody in the blood and combination of inciting substance and antibody (precipitin reaction). (d) Antibody combining with inciting substance in the bacterial cell (agglutination).

III. *Immunity of the third order.* 1. Inciting substance (anti-immune body). 2. Specific immune body having a cytophile group which combines with the inciting substance and a complementophile group which combines with the complement. 3. Complement or nonspecific immune body free in the blood. (a) Bacterial cell with inciting substance. (b) Inciting substance about to unite with side chain (amboceptor). (c) Immune bodies and bacterial cell free in the blood. (d) Union of three bodies in bacteriolysis.

tinating power of the blood of an immune individual he conceived to be due to the presence of these receptors of the second order which would be thrown off into the blood under continued stimulation, like the antitoxin type of receptor. This *immunity of the second order* is also illustrated diagrammatically.

The process of bacteriolysis which has an important bearing on immunity is of a different nature than the two phenomena just described. Students of this phenomenon found that the normal blood of animals has the power of killing certain disease germs to a limited extent, and that the blood of specifically immune animals has the power of killing and dissolving the particular organism for which the animal is immune to a great degree. It was also learned that the blood of an immune animal loses this power upon being heated to 56°C. but that the power is regained by the addition of a little normal serum from a nonimmune animal. Reasoning from these data Ehrlich assumed and later proved to his own satisfaction that, in this type of immunity, there is a nonspecific dissolving substance (complement) in the normal blood which is able to act upon the bacteria only in the presence of and by combining with specific side chains produced by the cell proteins in a manner similar to the way the above mentioned receptors are produced. The side chain of the body cell in this third type of immunity has two receptive parts. When such side chains or receptors are thrown out into the blood they unite with both the reactive substance of the germ cell and with the complement, which, acting through these receptors, is able to dissolve the bacterial substances. A similar reaction takes place when the body is immunized to foreign blood or other cells. Part three of the diagram shows the nature of this *third order of immunity.*

In all of the above-mentioned orders the immunizing substances are supposed to be produced by the body cells and they appear in the blood by the excessive regeneration of those first destroyed by the bacterial poison. The immune

substances of the first order, when they are free in the blood, are spoken of as antitoxins, those of the second order are precipitins or agglutinins, those of the third order are called amboceptors.

Vaughan has shown (*Protein Split Products*, Lea and Febiger, 1913) that split protein products from most proteins will produce a fever reaction if injected into the body systematically. Such substances are produced by almost all bacteria. It is a question whether the fever reaction produced by such organisms as the typhoid bacillus may not be due to these split proteins by a sort of consecutive anaphylactic poisoning rather than by specific endotoxins.

CHAPTER VIII

ORAL PROPHYLAXIS

In the chapter on the Hygiene of the Mouth we discussed the normal development and use of the oral structures in health. Here we are concerned with the prevention of septic and disease processes.

Caries.—All the pathological conditions of the dental pulp —calcareous deposits within these tissues excepted—and the series of morbid processes leading to the formation of alveolar

Fig. 21.—Deformity resulting from neglect of the teeth.

abcess are due (except in the case of traumatic injury) to the infection of this organ from the inroads of caries. The subject of dental caries has engaged the attention of scientific minds for more than four hundred years, and although much has been accomplished towards the solution of the problem, yet it still affords an ample field for laboratory research.

In 1530 a German writer published a statement so closely in accord with modern findings as to be prophetic of the later work of Miller and others. The following is a translation taken from Black's *Operative Dentistry.*

> Caries is a disease and evil of the teeth in which they become full of holes and hollows, which most often affects the back teeth; especially so when they are not cleaned of clinging particles of food which decompose, producing an acid moisture which eats them away and destroys them so that finally with much pain they rot away little by little.

Prior to the work of John Tomes, who gave to the world in 1860 the results of his microscopical studies of dental tissues, but little was known of the histological structure of the teeth, and caries was generally regarded as an inflammatory process, having its origin within the dentin of the tooth affected.

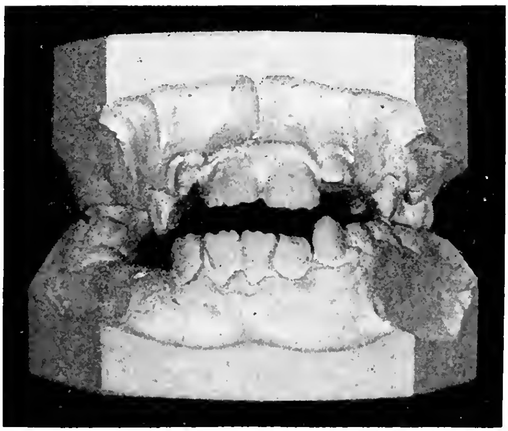


Fig. 22.—The case seen in Fig. 21 showing the malocclusion due to caries.

Tomes found that the structure of dentin was such that a true inflammation was impossible, there being no circulatory system. (An exception to the generally accepted opinion, prior to Tomes, is found in that of Robertson, who, in 1835, expressed the opinion that caries resulted from the action of acid due to the decomposition of particles of food retained in fissures and imperfections of the teeth.)

In 1857 Leiber and Rotenstein in the course of experimentation found that carious dentin, when stained with iodine, disclosed within the tubules granular bodies which were recog-

nized as bacteria. This is the first record of the association of bacteria as a cause of caries. Miles and Underwood in 1881 found that two factors were always active in caries, namely (1) the action of acids, (2) the action of germs.

Miller in 1882 announced the results of experiments conducted by him. His experiments were carried on with a view of solving the problem of caries of dentin, but little light was thrown on the problem of the initial lesion in the enamel.

His conclusions briefly stated are as follows:

(1) Microorganisms are always present in the tubules of carious dentin.

(2) The invasion of the tubules is preceded by decalcification of the dentin.

(3) The fermentation of carbohydrate foods by mouth bacteria produces lactic acid.

(4) Lactic acid causes decalcification of the dentin, this process being followed by the decomposition of the organic matrix.

Caries of enamel is undoubtedly due to the same phenomena that are operative in caries of the dentin. It differs in some particulars, as follows:

(1) The original foci of decay are generally found in distinct and definite locations.

(2) The location of each focus of decay is in a position favorable to the retention of food material.

(3) The food material retained in this location in the presence of warmth and moisture, affords a culture medium for acid forming bacteria.

(4) The undisturbed confinement of the acid formed in the fermentative process is sufficient to dissolve the enamel.

Why this carious process is active in some mouths and passive in others equally neglected remains undecided. It may be that in the normal secretions of some mouths there are substances capable of holding in abeyance the development of bacterial flora. It may be that through the refinement of food material and the development of epicurean tendencies,

which eliminate the necessity for vigorous exercise in mastication, the stimulating effect upon the secreting glands with the neutralizing action of a copious flow of saliva is lost. Or perhaps the solution of the problem lies in the resistance of the enamel itself due to its composition and density. Slight imperfections in the structure of the enamel are almost invariably present, thus making the dentin easy of access to the fermentative bacteria of the mouth.

Howe in his research work on caries at the Forsyth Dental Infirmary found that a few species of highly aciduric microorganisms were responsible for the carious process. He obtained these findings by first sealing carious cavities with cement, thus separating the carious material from the flora of the mouth. The bacterial cultures were later secured from the layer of carious dentin which had been thus isolated.

Although the problem of caries has been seemingly solved by the work of Miller and others, yet there are undoubtedly factors related to the question of immunity which are not yet understood; and it may be that nutrition plays a larger part than we now comprehend.

Diet in Relation to Decay.—Inasmuch as the protective covering of the teeth is fully completed at the time of eruption, too much stress cannot be laid upon the building up of these tissues or upon the diet of children up to the twelfth or thirteenth year. What constitutes a well-balanced diet is still a problem for research, but in viewing the subject from the standpoint of common sense it would seem that a study of the diet of the more primitive races, among whom normal development of the teeth is practically universal and who maintain the integrity of the teeth during the period of greatest susceptibility, would be illuminating.

The most universal food and the one containing in itself all of the three nutritive constituents, viz., proteids, carbohydrates and fats, is milk. Milk is also the richest of all articles of diet in the calcium content, this being the element of greatest importance in the development of the bones and

teeth. A liter of milk contains 1½ grams of lime, which is a larger quantity than is contained in a similar amount of lime water.

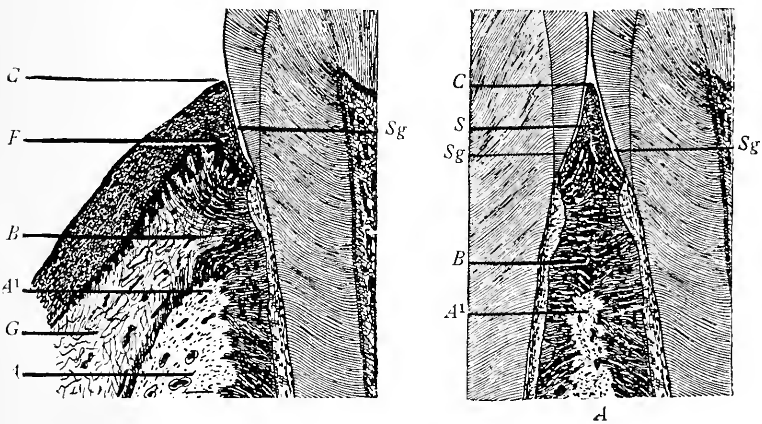
The mineral content of milk is sufficiently high to give it the first place as a bone building food, and as the teeth require practically the same elements for their proper development it is of equal importance as related to them. The infant requires about one-third gram of lime daily and this amount is supplied in milk. A deficiency in lime may lead to softening of the bones and imperfect development of the teeth. Next to milk come eggs, then the cereals and then certain vegetables such as carrots, asparagus and spinach. So necessary are these mineral substances in maintaining the fabric of the various tissues that death ensues if the supply is entirely cut off, even though the other constituents of diet are supplied in normal amount. The refining process to which many of the cereals are subjected in the manufacture of flour has the effect of depriving the grain of its mineral substance.

The mineral content of foods during gestation should be carefully considered in the dietary of the prospective mother, as the proper nutrition of the developing fetus is essential in the formation of enamel. On the other hand the development of the dentin, cementum and alveolar process takes place in a large measure after birth and continues throughout the life of the individual. Hence proper nutrition in infancy and later life is essential for the upbuilding of these tissues.

I would lay great stress on the habitual use at each meal of foods selected not only on account of the nutrient qualities, but also because they require sufficient masticatory effort to make vigorous exercise necessary in the performance of this function. The benefits of thorough mastication have been popularized by Mr. Horace Fletcher until Fletcherism has become a household word, and I am convinced that the beneficial results are more far reaching than even the most ardent advocate realizes. In the first place there is an invigorating effect upon the supporting structures of the teeth. Vigorous

mastication gives the necessary stimulation to the peridental membrane, which being richly supplied with blood needs this stimulation and functional activity for the maintenance of tone. There is an increase in the flow of saliva and exercise is afforded for the muscles of mastication. The passing of the food materials over the teeth cleanses their various surfaces and massages the gums and gingivæ.

The Care of the Gums and Gingivæ.—Black has divided the investing tissues of the mouth into two classes. First,



Diagrams illustrating nomenclature of gingivæ. (Black.)

Fig. 23.—Buccolingual section through tooth and investing tissues. *A*, Alveolar process; A^1, Crest of alveolar process; *G*, Gum; *B*, Body of gingiva; *F*, Free gingiva; *C*, Crest of gingiva; *Sg*, Subgingival space.

Fig. 24.—Mesiodistal section through first and second bicuspids and septal tissue. *A*, Alveolar process; A^1, Crest of alveolar process; *B*, Body of gingiva; *S*, Septal gingiva; *C*, Crest of septal gingiva just below contact point; *Sg-Sg*, Subgingival spaces.

the gums which clothe the alveolar process and hard palate, second, the gingivæ, which invest the cervical portions of the teeth; it is the latter which exercise an important protective function and play an important part in the prevention of disease; for it is in these tissues that the initial injury occurs which, if neglected, frequently leads to the infective process commonly known as Pyorrhea Alveolaris.

The gingivæ completely encircle the teeth passing over the

crest of the septum of the alveolar process and rising to a point just below the contact point between the proximal surfaces of the teeth. The crests of the gingivæ are not attached to the teeth but in health closely hug the portion which they encircle. The immunity to decay of the area of the teeth covered by this free gingiva is attributable to the perfection of its form and structure; it fits closely every part of the tooth, filling the interstices and guarding the tissues beneath from injury.

Insufficient study has been given to the function of these tissues and occasionally even the dentist, in the performance of restorative operations upon the teeth, has been negligent in his care of these delicate structures. There can be no doubt that in such cases he was responsible for the initial injury, which ultimately developed into a suppurative inflammatory process leading to the destruction of the investing tissues and to the eventual loss of the teeth. The hygiene of the gingivæ should command the closest attention of the dentist, and the cooperation of the patient. In many cases the removal of the serumal deposit from the surface of the tooth immediately under the free gingivæ will be sufficient to relieve the inflammation. This treatment should be followed at stated intervals by gentle massage with the finger; the stimulation to the circulation will be sufficient to restore these tissues to a normal state of health and resistance. The gingivæ should receive treatment in every performance of the toilet of the mouth and teeth. Gentle stimulation by proper brushing goes far to maintain firmness of texture and freedom from circulatory congestion, the prime factors in the health of the supporting structures of the teeth.

Inflammation of the gingivæ frequently is caused by injury from the crowding of food material into the interproximal spaces on account of faulty proximal contact due to malposition of the teeth or loss of proximal contact from the beginning of decay. The impacted food material first presses away the septal gingivæ, following this, putrefaction and fermenta-

tion take place. The soft tissue thus infringed upon and injured, loses its tone and becomes an easy prey to the micro-organisms of infection. When the septal gingiva is pressed down by the impaction of food material a pocket is formed, and an infection of the underlying structures soon takes place. The peridental membrane covering the root of the tooth is invaded and destroyed and its loss is followed by infection of the porous cementum covering the dentin of the root. Infected cementum, unlike necrotic bone, will not separate itself from the healthy tissue and nature has made no provision for its repair after the loss of the peridental membrane. It therefore becomes a dead septic area insusceptible to remedial treatment.

If the destruction of the peridental membrane is limited in extent, it may be possible by proper instrumentation to remove the septic portion and establish a new line for both the gum and peridental membrane; then by the exercise of extreme care by the patient and frequent attention by the dentist the progress of the destructive process may be checked.

Gingivitis.—The early recognition of the presence of a congested condition of the gingivæ and intelligent remedial treatment are fundamental in mouth hygiene. Only the trained observer will be able to do this, as the indications are so slight as to elude even such a one, unless the closest examination is made. These examinations must include a study of occlusion, contact points, and deposits. The removal of deposits and the correction of contact or the removal of occlusal strain will generally be sufficient to eliminate the sources of irritation. This treatment must be supplemented by personal care on the part of the patient who should be instructed in regard to the means available for permanently maintaining circulatory activity in these tissues. Back of all this is the function of nutrition. These means include thorough mastication, proper brushing of the teeth and massage of the soft tissue. Failure to treat these conditions in their incipiency frequently results in the establishment of chronic inflammatory condi-

tions, disastrous in their results. Prophylactic treatment of the gingivæ is as important as prophylaxis applied to the teeth.

Deposits.—Black has shown that an excess of calcoglobulin is thrown into the mouth with the saliva after the ingestion and assimilation of palatable food eaten of heartily. The deposits are paroxysmal, occurring at regular periods after eating. They become attached to any irregular surface in the immediate locality of the ducts of the salivary glands. It was possible to stop or produce deposits at will by the regulation of diet, eating to excess always produced a deposit. The deposit is at first very soft, and spreads over the surface of the teeth. It may be easily removed by careful brushing, the only difficulty being the inaccessibility of its position; but it may be reached if sufficient care is taken. It is necessary to explain to the individual the usual location of these deposits in order that he may intelligently effect their removal.

Another form of calcareous deposit, which has been termed serumal calculus, occurs in locations inaccessible to the saliva, the more common location being under the free margin of the gum and on the cementum of the roots of the teeth. The deposits are probably the result of an effusion of serum heavily laden with calcoglobulin resulting from inflammation of the gingival tissues. They seldom occur in the mouths of children. They are an additional source of irritation to the supporting tissues of the teeth and should be removed. As it is seldom possible to prevent their accumulation frequent examination by the dentist is necessary. The surfaces of the teeth should be freed from deposit and polished, great care being taken not to injure the gingiva or to detach its connection with the cementum of the tooth. Prophylactic treatment by instrumentation and polishing in the mouths of children should be done with extreme care and in many instances it is not indicated at all.

Prophylactic Treatment.—The great benefits to be derived from prophylactic treatment of the teeth and gingivæ were first brought to the attention of the dental profession and public by Dr. D. D. Smith of Philadelphia, who was able to demonstrate that dental caries in a large percentage of individuals is preventable. His treatment consisted in frequent polishing of the surfaces of the teeth with suitably shaped orangewood points impregnated with flour of pumice, the points being held in a porte-polisher. Patients were required to come for treatment as often as necessary, this being in many cases weekly or bi-monthly. Dr. Smith claimed much for this treatment, even to the assertion that a thorough massage of the teeth actually brought about changes in the character of the enamel, that enamel became more dense and highly resistant to the action of the destructive elements within the mouth.

It is quite obvious that in order to carry out the regime of Dr. Smith the dentist with a clientele of moderate size would be obliged to devote his entire time to the cleansing and polishing of teeth and that he would be unable to attend to the operations demanding his highest skill. It followed therefore that dentists undertaking to carry out this polishing, as a regular routine in practice, were obliged to seek aid; and the problem was finally solved by training young women to act as assistants.

The Dental Hygienist.—The legality of employing registered assistants for the performance of operations on the teeth gave rise to a controversy within the profession which finally resulted in an appeal to the legislatures of the various states and in the enactment of laws that placed the practice of oral prophylaxis upon a legal basis and created a new and useful vocation for women who are known as Dental Hygienists. The work of a dental hygienist is carried on in much the same manner as was originally done by Dr. Smith, some modifications and elaborations having been added since that time.

Through the efforts of Dr. A. L. Fownes, the first School for Dental Hygienists was established in 1914. Since that time

Fig. 25.—Dental hygienists at work in the Prophylactic Clinic for Boston school children at the Forsyth Dental Infirmary for Children. It is here that the Forsyth and Tufts School for Dental Hygienists is conducted.

several schools have been organized and are now in operation. The Forsyth Dental Infirmary for Children has a training school in affiliation with Tufts College Dental School, and there is another school at the Rochester Infirmary which was established through the benefaction of Mr. George Eastman of Kodak fame; and a fourth school at the Dental Department of the University of Minnesota.

The dental hygienist is given a good perspective of the field of dental practice and is thoroughly trained in the activities which she is to undertake. Not only does she clean and polish teeth but in addition she is able to assist in anaesthesia, x-ray work and the preparation of patients for operations.

The recent and rapid development of dental hygiene work among school children has created an opening for dental hygienists in the official health organization of many communities. The young woman of proper training and suitable personality is extremely valuable in school work since her enthusiasm and her ability to get on well with children especially qualify her for both clinical and educational work. She examines the teeth of the children, fills out the dental chart indicating the defects and arranges for the visits to the school dental clinic. When the child arrives for treatment it is the hygienist who allays its fears, prepares the mouth for treatment, cleans and polishes the teeth and assists the dentist in operative work if this is necessary. Instructions in dental hygiene and the conducting of toothbrush drills may devolve either upon the School Nurse or the Dental Hygienist. At present there are, unfortunately, far too few graduates in Dental Hygiene to supply the demand for such services.

Daily Care of the Teeth.—We have stated that caries of the enamel is largely due to the retention or confinement of food material in locations favorable to its remaining undisturbed for a sufficient period of time for fermentatien to take place. This being the cause of the formation of cavities and decay, it is obvious that if this food material can be

removed before the bacteriological action takes place, the dissolution of the tooth substance will be prevented. With the most scrupulous care it is impossible to entirely prevent caries in highly susceptible mouths where it is very active, but the frequency of occurrence may be greatly lessened. After five years' supervision of the school children in the City of Bridgeport, Fones reports that caries has been reduced from 30 to 60 per cent in the various schools. The children were carefully drilled in the use of the toothbrush and home care was insisted upon. In conjunction with this, frequent prophylactic treatment by the dental hygienist was given.

We believe that the care of the teeth should begin as soon as the child is put upon a mixed diet and even before this if there are evidences of accretions upon the surfaces of the teeth. The brush should be of suitable size to suit each individual case, not too large to pass between the lip and cheek and the surfaces of the teeth, and with bristles neither so stiff and resistant as to cut the soft tissue nor so soft as to be ineffective in the removal of soft material. Prior to use the new brush should be soaked in boiling water. No definite method or rule can be made for brushing these teeth. The parent or nurse must take care that it is done thoroughly without injuring the soft tissues.

Method of Brushing the Teeth.—The child should be early taught to use the toothbrush properly. Whatever method is advocated the object is the same, namely the removal of all extraneous material and the stimulation of the soft tissues without injuring them.

Fones advocates the following method of brushing:

> Place the toothbrush inside left cheek and on upper gums, and nearly close the teeth together. Make the brush go backward and downward to lower gums, then slightly forward and upward until it has traveled a complete circle. This circular motion should be done rapidly so that the gums will be stimulated and the teeth cleansed of food.
>
> Keep up this fast circular motion and brush all the teeth on the left side as well as all of the front teeth. Do not brush the teeth and gums crosswise.

Now brush the right side with the same circular motion or reversing the circle if found more convenient. Brush long enough to thoroughly stimulate the gums and cleanse the teeth, going back and forth over all the surfaces several times.

With the bristles of the brush pointing upward and the end of the thumb on the back of the handle, brush the roof of the mouth and the inside gums and surfaces of the teeth with a fast in-and-out stroke, reaching back on the gums as far as you can go. Go back and forth across the roof of the mouth with this in-and-out stroke at least four times.

Hold the handle of the toothbrush in your fist with the thumb lying across the back of the handle and brush the gums and teeth with an in-and-out stroke, using chiefly the tuft end or toe of the brush. Reach back in the mouth on the gums below the last tooth on both sides and brush with a fast, light, in-and-out stroke. Tip the handle of the brush up in brushing the gums back of the lower front teeth.

Lastly, brush the teeth with an in-and-out stroke on the surfaces on which you chew, as the food must be removed from the grooves or fissures of the molars.

The writer prefers the following method described by Black in the chapter on Mouth Hygiene in his *Special Dental Pathology*. Beginning with the left side of the lower jaw, after the brush has been moistened in water or normal salt solution and lime water, the end should be carried back to the last molar or beyond when possible. The ends of the bristles of the brush should be placed against the gums over the roots of the teeth. Then with either a straight or twisting motion of the wrist the brush should be swept over the teeth toward their occlusal surfaces. This should be done several times. The same procedure should be repeated with the right side.

For the upper jaw the brush is placed far back on the gum first on the left side. The bristles are swept over the gingivae and teeth in the direction of the occlusal surfaces. The same procedure is used for the right side. Particular attention is called to the fact that the motion of the brush is first over the gums, next over the gingivæ and next over the buccal surfaces of the teeth to the occlusal margins. Then the brush is lifted and replaced upon the gums as before and again swept over the gingivæ and teeth.

The motions for the lingual surfaces of the lower molars should be practically the same as those for the buccal surfaces but they are more difficult to make correctly. The same may be said for the lingual surface of the upper molars. In brushing of the lingual surfaces of the incisors the handle of the brush should project out of the mouth parallel to the length of these teeth. The brush held in this position should be placed on the gum and the motion of the brush should be

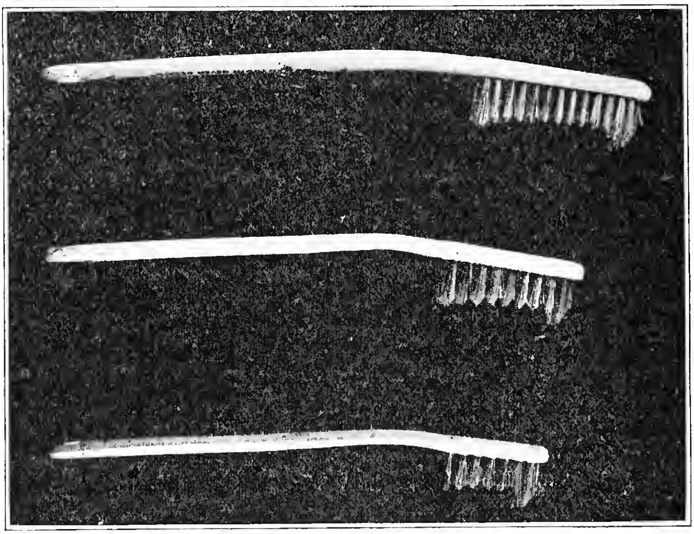


Fig. 26.—Tooth brushes of proper shape and material are made in different sizes for children and adults. The cut shows such tooth brushes exactly one-half normal size.

over the gum, gingivæ and teeth. The brush should then be lifted and replaced on the gum and the motion over the gum, gingivæ and teeth repeated several times. The brush may be moved from side to side across the lingual surface of the teeth close to the gum for removal of deposits which may have been missed by the other movements. This brushing should include the gum. The occlusal surface of the teeth should also be thoroughly brushed.

The teeth should be brushed with sufficient frequency to prevent the fermentation of food with the formation of acid. Four times a day has been advocated, once after each meal and before retiring at night. The time of greatest importance is before retiring; for in sleep the muscular tissues of the mouth are at rest and the oral secretions greatly lessened, thus affording the most favorable opportunity for undisturbed action of the acid-forming bacteria. This final brushing should never be neglected. The danger of infection of the soft tissues of the mouth by proper brushing is so slight as to be practically negligible.

Care of the Brush.—As the result of experiments to determine the most hygienic method of caring for the brush the authors have found that a brush rinsed in water after using and then placed in a closed receptacle developed many more bacteria than one which was rinsed in hot water and left in the air to dry. It is therefore advised that the brush be thoroughly rinsed in *hot* water after each use. The brush should be freed from water as much as possible by shaking and then hung in the air in a place protected from the dust.

Dental Floss.—The use of dental floss is to remove any particles that may remain upon the proximal surfaces of the teeth after brushing or after eating when it is not possible to brush the teeth. The silk should be passed through the contact points and held closely to the surface of the teeth and carried upward or downward as far as the gingivæ. Care must be taken or injury will be done. If the contact point is close, the force used may result in the sudden passage of the floss and carry it against the soft tissues so roughly as to cause damage.

Toothpicks.—The toothpick is also used to clean the proximal surfaces of the teeth after eating. An orangewood pick with a smooth flat blade or a quill is to be preferred and care should be taken not to injure the soft tissues or push the gingivæ away from the surfaces of the teeth. Too often people blindly and violently thrust the toothpick be-

tween the teeth, in an attempt to relieve some slight irritation, until actual bleeding of the gums is produced. Another vicious and unsightly habit is the prolonged use and chewing of the cheap wooden toothpick from which splinters are detached to irritate the membranes of the mouth and throat. The toothpick should be used privately, not publicly.

Mouth Washes, Tooth Powders and Pastes.—Prinz states that the *sterilization* of the oral cavity by any antiseptic which can be employed with safety is impossible. This being the case, the use of commercial preparations advertised to do this is not only useless but may be harmful, and their use should be condemned.

We have shown that the saliva possesses many of the desirable qualities of a mouth wash. The ideal *mouth wash* should be of a similar nature, with the addition of a bactericidal property. The qualities of the mouth wash should be such that it will not irritate the soft tissues, that it will not destroy the salivary ferments, that it will be bactericidal, that it is not poisonous if swallowed. The wash should be readily available and inexpensive so that it may be used freely and without harm. The writer has for many years advised the use of salt and water for this purpose. Prinz has shown that physiologic salt solution reduced the oral flora by 50 per cent, and he advises the use of this solution with the addition of half an ounce of lime water to eight ounces of a salt solution. The lime water is mildly astringent and is a solvent of mucinous material. Fones advocates the use of lime water alone, and states that five cents worth of coarse unslaked lime such as the masons use for coarse plaster will keep a family supplied with the best kind of mouth wash for a whole year.

Tooth powders are largely used as an aid in mechanically cleansing the surfaces of the teeth. Much injury may result from the use of an abrasive material and only the finest precipitated calcium carbonate should be used for this purpose. This may be combined with a small amount of soap and sac-

charine and flavored with one of the essential oils. A suitable powder may be made by thoroughly mixing a half-pound of finest grade English precipitated chalk with three grains of finely powdered saccharine, a half-ounce of powdered castile soap and 50 to 100 drops of oil of wintergreen or peppermint.

Pastes are made by adding gelatine or glycerine to the powder.

Tooth Cleansing Foods.—The use of slightly acid fruit as the last article of food to be eaten in a meal is to be commended for its efficacy in the removal of sticky particles of food and its stimulating effect upon the salivary glands, thereby promoting a free flow of saliva which quickly neutralizes the acid. The lunch which the child carries to school should contain an apple or an orange for dessert instead of the jam, cookies and sweets so often used.

Care of the Mouths of Children.—It is of the uttermost importance that the growing child should be taken to the dentist for frequent examination. Beginning at the age of three years a careful inspection should be made at least every three months. This inspection should include not only an examination for cavities of decay, which should be immediately treated or filled, but also a study of the dental arches to determine whether normal development is taking place. Slight stimulation by properly directed but gentle force may be necessary to bring this about. If retarded development is discovered early, very little interference is necessary to stimulate growth but if neglected the consequences may be serious. The treatment of incipient caries by the dentist by the use of nitrate of silver will frequently inhibit decay, and the necessity for filling the deciduous teeth may be avoided.

Septic Teeth as a Source of Systemic Disease.—During the past five years much has been written on this subject and investigators of prominence both in medicine and dentistry have, after exhaustive research, arrived at conclusions so similar as to justify the statement that in a variable percentage of persons suffering from lesions of the kidneys, heart

and joints, x-ray and bacterial examination will reveal the presence of septic foci around the roots of one or more teeth. The removal of these teeth is often followed by marked improvement of the general symptoms.

Rosenow (*Journal of Dental Research,* Vol. 8, No. 3, Sept., 1919) states, that the number of persons suffering from diseases directly attributable to dental foci of infection as well as from nonrelated conditions which have been cured or benefited by elimination of foci of infection, in various branches of medicine, is so large as to be quite sufficient to prove the general truth of the idea of causal relationship. He advises the removal of all nonvital teeth in persons suffering from arthritis, heart or kidney affections, and some other forms of disease for which other causes cannot be found. It is easy to see the possibility of an infection spreading from the region of the mouth to other parts of the body; but we believe that the number of cases attributed to this cause is greatly overestimated. Cases are on record showing an undoubted relationship between systemic infection and dental foci by the marked improvement produced by the elimination of the diseased teeth. But to act upon the hypothesis that diseased teeth represent the sole cause of these systemic diseases and to advise wholesale removal of useful organs, is entirely unwarranted. Certainly teeth should never be removed merely because no cause for systemic disease is apparent. This is a matter in which the dentist must take an independent stand and his knowledge of dental pathology should be sufficient to enable him to determine whether or not extractions should be made, whatever may have been the prescription of an attending physician. There is no excuse for the indiscriminate extraction of useful teeth.

Taking the opposite point of view from that of Cotton, Rosenow, Hartzell and others, Howe states that "a focus of infection is a localized pathological area in which bacteria are to be found. Here the process is centralized and if the forces of immunity are unimpaired, the bacteria if not actu-

ally destroyed are walled off from the rest of the human system, moreover, the individual attains a high and specific immunity against this specific morbid process. Bacteria are not discharged freely into the circulation to wander at will and to settle without rhyme or reason at any point they choose. Once they enter the blood they are easily disposed of by all the forces of immunity."

While this statement seems a sane viewpoint, especially so when the comparative minuteness of the septic area involved in the chronic alveolar abscess is considered, yet the degree of acquired immunity to any given organism may be variable or even lost, and it is in the period of lowered resistence that the possibility of systemic infection is present.

Were this not the fact, the danger of general septicemia from infective processes in any part of the body would be negligible. That this is not the case is amply proven by clinical experience, and by the fact that the first surgical law in the treatment of any abscess is the establishment of drainage. That there is an element of danger in the presence of oral septic conditions would seem to be implied by Dr. Howe's statement that "all oral septic conditions should be cleared up." Better still would be the statement that septic oral conditions should be prevented.

There is some evidence that certain types of insanity are produced by abnormal mouth conditions. It is perfectly reasonable to make a distinct connection between the disturbances of the mental equilibrium and a local condition where pressure upon the nerves is exerting a constant zone of irritation such as an impacted condition of the teeth. This is undoubtedly shown in the nervous manifestations which occur during the period of dentition in childhood. It is much easier to conceive of neuroses being related to conditions of impaction than to understand how they can be related to conditions of infection as some medical writers believe. Cotton says that "in about 25% of the cases of the functional types and dementia precoxia groups, foci of infection in the teeth alone are the

etiological factor, and extraction of the affected teeth is followed by complete recovery.'' Corroboration from many sources would seem necessary before accepting such a sweeping statement and one so far reaching in its effects.

The fact that the loss of the vitality of the dental pulp through the inroads of caries and the infected organic matter contained in the tubuli of the dentin is the primary cause of a very large percentage of these foci at once suggests the possibility of the absolute prevention of these serious systemic conditions by hygienic measures.

While it may not be possible to prevent the formation of cavities of decay in the teeth which may eventually infect the dental pulp and lead to its death, yet careful regard of the principles of hygiene and the reinforcing of the protective agencies supplied by Nature, proper attention to diet and the exercise of the function of mastication will be effective to a surprising degree.

In view of the possible far reaching effect of dental disease it becomes the prime function of the dentist to instruct those coming under his care in such a way as to make clear the measures at hand for the prevention of dental caries.

CHAPTER IX

COMMUNICABLE DISEASES

Three Great Plagues.—Diseases which are spread because of the existence of unsanitary conditions have been rapidly brought under control, but the diseases which are spread largely by personal contact have not been correspondingly reduced. Perhaps no illustration is better than the communicable disease history of the army during the four last wars. We may show graphically how the number of disease deaths have declined in relation to the number of battle deaths. This is a remarkable achievement but it is chiefly an achievement of sanitation. Intestinal and insect borne fevers have been almost eliminated. On the other hand the respiratory disease rate remains very high. Pneumonia caused 13 per cent of the deaths of the Civil War and but 3 per cent of the deaths in the Spanish War. But in the recent war it was a dread disease and caused 85 per cent of all deaths from disease, having a death rate of over 9 per thousand. If the respiratory diseases had been eliminated from our army in the world war the army disease death rate would have been practically that of the civilian population.

In civil life as well as in warfare the diseases transmitted by mouth and nose secretions present a great unsolved problem. It is not our purpose to consider here the detailed pathology or the administrative methods of control for the various communicable diseases. *Appendix A* contains a brief but comprehensive summary of the public health facts regarding them. There are however, three diseases or groups of diseases which are of paramount importance to society and which particularly interest the dental practitioner because they are communicable and because the infective organisms are found

in the oral cavity. We may refer to these diseases in popular language as the Great Red Plague, the Great White Plague and the Great Pandemic. They are syphilis, tuberculosis, and common cold. Progress can be made against these scourges

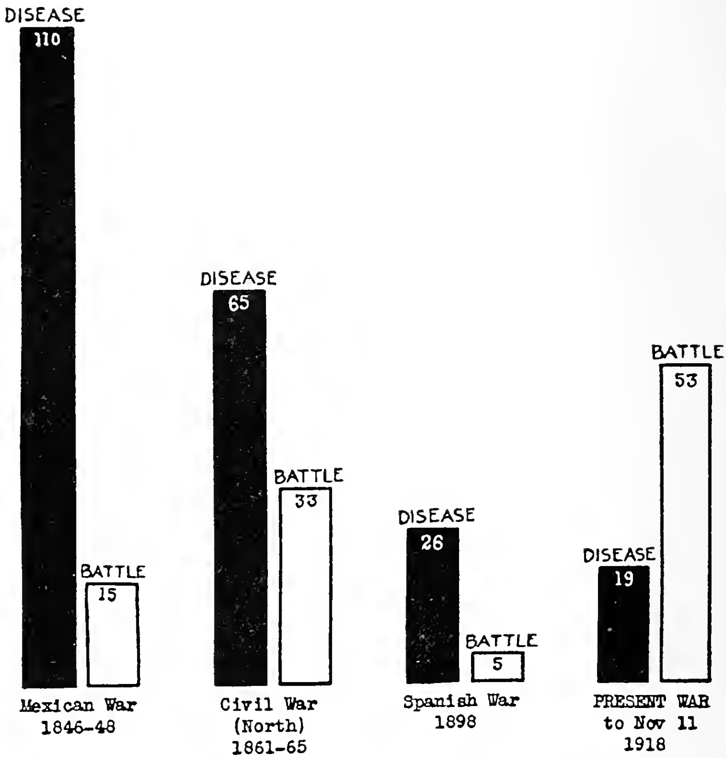


Fig. 27.—Comparative figures showing the number of disease and battle deaths each year per thousand troops in the wars of the United States. (United States Army figures.)

only by a broad and almost universal knowledge of their nature, their seriousness, transmission and the methods by which they may be combated.

TUBERCULOSIS

Prevalence.—Descriptions of tuberculosis may be found in the earliest medical writings. It has always been an important disease. It is the most wide spread of all infections and correspondingly the greatest single cause of the death. At least 9 per cent of all deaths are due to this disease. Ten

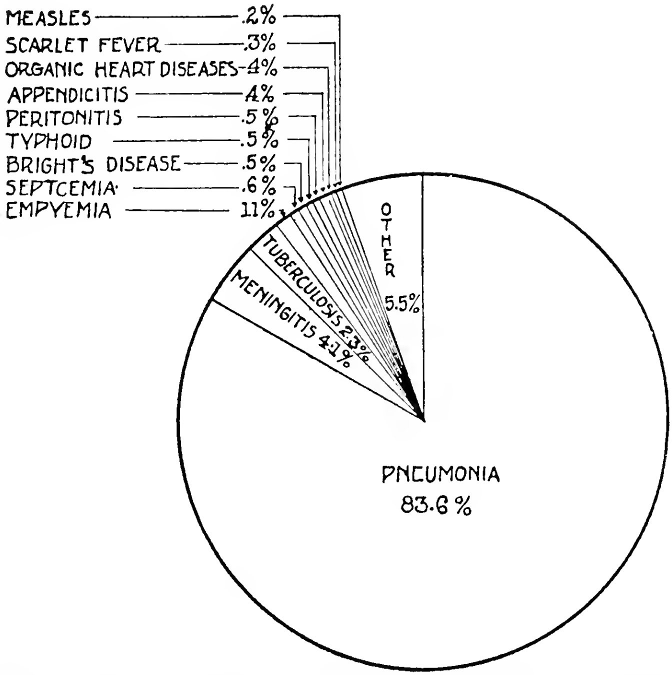


Fig. 28.—The relative proportion of army deaths caused by the principal diseases in the war with Germany. (United States Army figures.)

million of the people now living in this country will die of tuberculosis and yet it is a preventable disease; we know its cause and we know how it may be prevented. It is most unfortunate that tuberculosis is a disease of young people and carries away its victims in the prime of life at the height of their earning and productive capacity.

It has been estimated that the number of cases of tuberculosis in any community is approximately 10 times the number of annual deaths from the disease. That is, if a town has 50 deaths from tuberculosis in 1920 it probably has 500 active cases. This figure has been confirmed by the recent tuberculosis experiments conducted by the Metropolitan Life Insurance Company in the city of Framingham, Massachusetts. When this work was started there were three known cases of tuberculosis per annual death in the city. Large blocks of the population including thousands of people have received physical examinations during this health experiment and a tuberculosis expert has been provided who gives free consultation to the practicing physicians. The present figures show 9 cases of active tuberculosis and 11 cases of arrested tuberculosis per annual death.

The Difficulties.—Why is it that the Great White Plague continues to take its annual toll in lives of our people while typhoid is being rapidly banished from our country? The following are some of the difficulties in combating tuberculosis:

(1) The disease is transmitted by contact and therefore has not the same direct relation to sanitation as does typhoid fever.

(2) There is no way of producing an artificial immunity by the use of vaccine, and there is no satisfactory method of serum treatment. The reaction of the body to tuberculosis is cellular and not antitoxic. Instead of producing a chemical substance to combat the organism the body walls off the tubercle bacilli by the white blood cells and encapsulates them by the cells of the connective tissues. To be sure, the body becomes sensitized or anaphylactic from the first infection so that it may react more promptly, but since the reaction depends upon cell activity the bodily resistance depends upon the vitality of the individual and not upon a chemical substance.

(3) Bodily vigor which makes it possible to resist tubercular infection is impossible of universal attainment. It is very simple to say that fresh air, nourishing food, and sufficient sleep, will prevent or cure incipient tuberculosis but these very simple things are just what many people are unable to secure. Under the economic basis of society it is not possible for everyone to have healthy work, sufficient recreation in the open air, and a suitable diet.

(4) The disease is so benign and its onset so gradual that society is not aroused against it. A tuberculosis patient is often cheerful up to the very day of his death and there is nothing startling or terrible about the first stages of the disease. If tuberculosis were accompanied by a high fever and a disagreeable rash as is smallpox, then rapid progress would be made in its elimination but as it is, we somehow conclude that because it is common it is not dangerous in spite of the fact that 1 out of 12 of our acquaintances will probably die with this preventable disease.

Transmission of Tuberculosis.—It is to be remembered that there are two strains of organisms which produce this disease, the human and the bovine, and that there are many types of the disease, although phthisis or tuberculosis of the lungs is the most common form. Many other parts of the body are attacked including the bones, the meninges and the glands.

Glandular infections among children are very common and a large percentage of such infections are with the bovine strain. It has been stated that from one-fourth to one-third of the tuberculosis in children under five years of age is caused by the bovine type of bacillus which is probably ingested with cow's milk. Recent hospital records show the bovine bacillus to be the cause of 80 per cent of the glandular cases in children under 4 years of age and the cause in 100 per cent of such cases in children under one year of age. Records from a large number of cervical gland operations in children show that 65 per cent of gland infections were tuber-

culous and in 90 per cent of these the organism was the bovine type. Infection is therefore possible both from man and from animals and may be acquired both by inhalation and ingestion.

The chief source of infection from man is the sputum and it was formerly thought that the organism was most commonly acquired by being breathed into the lungs in droplets sprayed into the air by the cough of the tuberculous patient or in the form of dust. This type of infection does take place. Cornet was able to infect 47 out of 48 guinea pigs exposed to the dust produced by sweeping a carpet which had been purposely infected with tuberculous sputum but this was an unusual condition and the dose of the infection was great. Moreover the continual breathing of dust irritates the lungs and makes it easier for the bacillus to gain a foothold. But although infection by inhalation does occur we have probably overestimated the importance of this method in the past.

We have recently come to regard more seriously the probability of infection through ingestion. The opportunities for infection in this manner are countless and it has been shown that the organism may make its way from the throat and tonsils to the glands of the neck and from the small intestines to the abdominal glands, to the lungs and other parts of the body. No doubt the presence of decayed teeth and infected tonsils makes it easier for the bacilli to multiply in the body by providing acceptable lodgings in the mouth and throat and by reducing bodily resistance.

We must accordingly recognize the danger of tuberculosis infections from contact in any of the various ways by which the infectious material from a tuberculous patient may reach our mouths. It may be that we handle infected material and then carry the fingers to the mouth or it may be that the infection is carried by milk, flies, cups, handkerchiefs, or other articles. This danger should make us more careful of food sanitation.

The number of bacteria taken into the body is important as it has been shown that men and experimental animals can resist a limited amount of infection. In fact investigators assert that almost every individual who has lived to the age of 25 or 30 years will show tubercular lesions at autopsy, although they may never have developed clinical symptoms of the disease. It seems therefore that everyone must receive tubercle bacilli. The question of whether we have tuberculosis or not depends upon the size of the dose and our degree of natural immunity, which in this case is directly related to general health.

Tuberculosis is not hereditary although it is possible that some predisposition to it may be inherited. Of course if the child is taken care of by a tuberculous mother there is great opportunity for early infection.

The disease may indeed be spread through contaminated water supplies. Sputum which has not been disinfected frequently finds its way into the sewer and the feces themselves contain tubercle bacilli. These organisms are enclosed in a little fatty sheath and are therefore more resistant to cold water than many other organisms and it seems reasonable to believe that they may be present in a polluted water supply, especially since the vital statistics of various cities have shown a reduced amount of tuberculosis when the water supplies were improved.

Prevention and Control.—We have in our hands many weapons for combating the disease which we are not always using to the best advantage. Some of these may here be described.

1. *Education.*—In order that our campaign may succeed the people must understand the facts and the seriousness of the disease. Fortunately the message is a hopeful one because tuberculosis is curable. The public should know this but it should also know that it is transmissible. Many infections could be avoided by better personal prophylaxis if people would insist upon good ventilation, refuse to use common

drinking cups or unpasteurized milk from cattle which are not tuberculine tested and if they would avoid intimate associations with cases of tuberculosis. Much could be done also by securing a desire for wholesome diet and by removing mechanical obstructions to breathing and other predisposing factors.

2. *Segregation.*—Much can be gained by separating the tuberculous patient from uninfected individuals. Hospitals should be provided for the advanced cases and sanatoria should be available for the incipient cases. There is a practical difficulty here, for hospitals and sanatoria are expensive and it is not always possible to persuade the individual most needing the treatment to accept it. We have been particularly lacking in sanatoria where the middle classes of society could receive treatment at a reasonably low cost. The legal power to forcibly remove, isolate, restrain and keep under treatment the *irresponsible* and *incorrigible* consumptive is needed for the welfare of the community.

3. *Home Treatment.*—Even if enough sanatoria could be provided there are often disadvantages in removing a patient from his home and it is fortunate that so much can be done by home treatment if it is properly carried out. Dispensaries should be provided in every community for the diagnosis, treatment and instruction of the consumptive. If this phase of the work is properly conducted any case may receive prompt and early diagnosis and may be taught how to avoid infecting other people. Something may be done to secure better housing conditions, a more suitable type of work and an improvement of diet. If the patient will honestly, intelligently, and conscientiously obey instructions he may have every hope of improving his condition in his own home, provided the disease is not too far advanced, and he will probably do better in mind and body if his home is not broken up. If the patient is unintelligent or incorrigible there is little hope for his recovery under any consideration and society must safeguard the health of the people who would be brought in contact with him and endangered by his carelessness.

4. *Tuberculosis Societies.*—The National, State and Local Societies for the Prevention of Tuberculosis are important factors in combating the spread of the disease. What is everybody's business is nobody's business and it is altogether too easy for the governmental agencies to neglect obviously needed activities for safeguarding the health of its citizens. Often the health official would like to do more but careless and un-

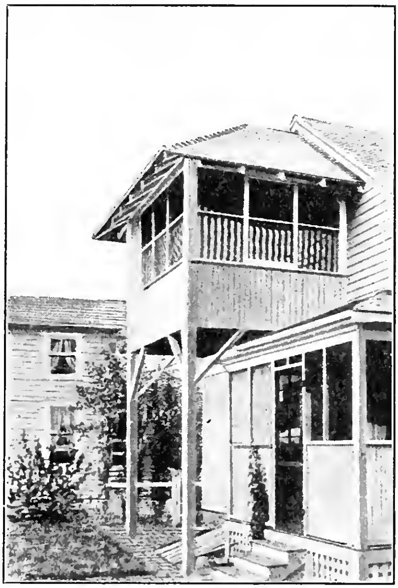


Fig. 29.—An inexpensive and easily constructed outdoor sleeping porch.

informed public sentiment will not support him. Fortunate is the community which has a group of interested citizens or an individual who can organize the necessary campaign for disease control. Successful campaigns of this type usually involve certain definite steps. The press, the physicians, the politicians, the Chamber of Commerce, the business interests of various groups must first be aroused and interested; then a local committee is formed and a tuberculosis exhibit is se-

cured from the National Society for the Prevention of Tuberculosis or from the State Board of Health. A local tuberculosis society is formed, a dispensary is established with a physician and nurse in charge and then a day camp may be provided. The municipal authorities are usually ready to take over the work at this point and carry it on with whatever additions and improvements may be necessary.

SYPHILIS

Venereal diseases present what some public health workers regard as our most important health problem and yet little was done in an official way for their scientfic prevention previous to the last decade. In one of the three venereal diseases (syphilis) mouth lesions are very common and the dentist may have to work upon infected individuals. But we wish the dentist to appreciate the social as well as the professional aspects of the disease and we shall therefore treat both phases of the question.

Importance.—Syphilis did not appear in the civilized world until 1493. There is evidence (*Journal American Medical Association,* June 12, 1915, Vol. LXIV, 24, p. 1962) that it was carried to Europe by the crew of Columbus on the return of his first voyage. By those members of the crew who joined the army of Charles VIII of France it was carried into Italy with the invasion of that country for the conquest of Naples in 1494. The epidemic which began there rapidly spread over all Europe with the most serious consequences, for the disease was then new and its course was extremely rapid and severe.

The seriousness of this disease has not been realized because its existence has been hidden. Until recently the only accurate data which we have had regarding the presence of the disease were secured from military organizations. It has been easy to conceal the presence of the disease in civil life because the infected individual is not physically incapacitated during

its early stages. Kober (*Transactions Association American Physicians,* Philadelphia, 1911, Vol. XXVI, p. 155) gives a table showing the prevalence of the disease in certain military groups for specific years.

DIFFERENTIATED INFECTIONS PER THOUSAND MEN

	Year	Syphilis	Chancroid	Gonorrhea	Total
U. S. Army	1909	30.45	30.77	135.77	196.99
U. S. Navy	1909	26.49	28.23	105.11	159.83
Japanese Navy	1907	....	....	.....	139.75
British Navy	1908	37.46	17.87	67.16	122.49
British Army	1908	35.1	28.23	40.7	75.8
Japanese Army	1907	10.1	10.4	17.1	37.6
Prussian Army	1907	4.4	2.1	12.2	18.7

The variations of this table as well as more recent figures from our own army indicate that much may be done to limit the amount of infection. The following figures are taken from a statement of Colonel P. M. Ashburn, contained in *Report of Hearings* (H. R. 5123) *Excluding Advertising of Cures for Venereal Diseases from the Mails.*

ARMY VENEREAL INCIDENCE RATE PER 1,000 FOR PRECEDING YEARS

YEAR	RATE	YEAR	RATE
1911	163.49	1914	110.69
1912	136.70	1915	107.71
1913	99.22	1916	103.35
		1917	113.82

Incidence in Camps during War per 1,000.........60
Incidence in A. E. F. during War per 1,000........45

We have recently learned more about the venereal diseases in civilian as well as military life. That venereal disease control is a civilian as well as a military problem is shown by Dr. W. A. Sawyer, Major M.C.,U.S.A. (*American Journal of Public Health,* May, 1919) who states the result of special reports rendered by Camps Upton, Dix, Meade, Lee and Pike for a period of 24 weeks from March 29, 1918 to November 15, 1918. Taking these five camps together the annual venereal disease rate for the entire period was 347.88 per thousand men. The rate for cases contracted in civil life and recorded as of the

date when first discovered was 336.96, while the rate for cases contracted after enlistment was only 10.92. Less than $1/30$ of the 42,032 cases in these camps were contracted after enlistment. Major Sawyer believes that for all the troops in this country including the organizations that had been longer in the service than the newly drafted men mentioned above five to one was a close estimate of the ratio between the cases contracted before enlistment and those contracted afterwards.

In spite of prompt isolation, thorough and proper medical treatment, the compulsory use of prophylactic stations, the elimination of prostitution so far as possible in the region of camps and a thorough educational program, there was a loss to the army representing 2,195,000 days of service between April 1917 and September 1918 (*United States Public Health Service Reports,* Oct. 24, 1919). However, even in the absence of specific records we may be certain that this is a relatively slight time loss compared with that of previous wars.

Some idea of the more serious effects of syphilis are found in a study of Mattauschek (*Medicinische Klinik,* 1913, Vol. IX, p. 1544) who investigated 4,134 cases of the disease occurring among officers of the Austrian Army between 1880 and 1900. Of these officers 14.64 per cent were dead or disabled as a result of the disease. Of this group 20 had died, 198 had severe paresis, 113 had locomotor ataxia and 132 had cerebrospinal syphilis, 80 of whom were insane.

But these figures do not tell the whole story because the disease although hidden from the public greatly reduces the vitality of its victims and an early death is likely to occur from a variety of other causes. Very few of the insurance companies will accept syphilitics as risks and even those companies which accept cases after thorough treatment usually refuse to carry the individual after 55 years of age.

The effects of this disease upon the offspring are perhaps more serious than the effects upon the diseased parents. The active disease may be inherited from either the father or the mother; or serious defects may be transmitted to the offspring

because of the presence of the disease poison. These more frequently manifest themselves in serious abnormalities of the nervous system.

Nature of the Disease.—When an infection is produced by Treponema pallidum there first occurs a hard indurated ulcer or chancre in the skin or mucous membrane at the site of the initial infection. But the spirochetes soon invade the whole system and the second stage of the disease is marked by fever, anemia, the involvement of lymph nodes, and eruptions upon the skin and mucuous membranes. The mucous patches in the mouth appear at this time and the disease is highly infectious. During the third stage of the disease localized granulomatous growths (gummata) appear in the various organs of the body and it is following this stage that the serious effects upon the central nervous system are produced.

Transmission.—The spirochete of syphilis has been shown (Zinser and Hopkins: *Journal American Medical Association*, Vol. LXII, p. 23, June 6, 1914) to persist on a moist towel for 11½ hours. It does not resist dryness and will not grow after having been dried on a slide for one hour. It is a relatively frail organism but of such viability as to be transmitted in other ways than through sexual approach. In fact accidental infections, contracted outside of venery, are more common than is ordinarily supposed. Even a slight scratch in the skin is sufficient to permit the introduction of the virus as has often been demonstrated by infections upon the hands of surgeons and in the practice of midwifery. It is possible for the disease to be transmitted by kissing, or by the use of common drinking cups or common towels. *Dental instruments,* the barber's razor, pipes, spoons, or glasses, may convey the infection if proper precautions are not used. This possibility for innocent infection makes the disease a menace to every member of the community because syphilis is present in every class of the social scale.

Immunity.—There is an immunity conferred upon a nonsyphilitic fetus by the syphilitic mother and an immunity

conferred upon the nonsyphilitic mother by the syphilitic fetus. The first condition was long ago set forth by Profeta's Law which holds that a healthy child will not contract syphilis from nursing a syphilitic mother. The other principle is known as Baume's or Colles' Law which asserts that a syphilitic child born of a healthy mother will infect the most healthy nurse but not its own mother. There is no natural immunity to syphilis.

Prevention.—A study of the methods of control enumerated for this disease in *Appendix A* will show that we have recently made a good deal of progress in combating the malady. The emergency of war allowed the inception of a general campaign against it. Now the people as well as the physicians and health officers realize that the venereal diseases must be treated like all other contagious diseases if they are to be eliminated. Consequently it has been possible to establish measures to secure the reporting of cases, and their continued treatment. Aided by the Chamberlain-Kahn Bill, which provided conditionally for the distribution of $1,000,000 among the State Boards of Health each year for the two fiscal years beginning July 1, 1918 together with other appropriations for activities within the Bureau, the U. S. Public Health Service has conducted its campaign against venereal diseases by assisting in:

1. Securing prompt reporting.
2. Carrying on repressive measures.
3. Establishing free clinics for treatment.
4. Carrying on a general educational campaign.

Forty-six states (all but Pennsylvania, Nevada and the District of Columbia) adopted the regulations necessary to obtain their quota of Federal money for the first year. This involved the establishment of a special Department or Division of Venereal Diseases and the institution of proper control regulations. It is to be hoped that this disease will in

the future receive the attention it deserves from health authorities and be handled like other communicable diseases.

An idea of the treatment facilities furnished by the U. S. Public Health Service and the State Boards of Health may be obtained from the following summary of the July report (*Public Health Report,* September 5, 1919). During this period 131 clinics were operated and for the month 5,624 new cases of venereal diseases were admitted making a total of 16,871 under treatment. A total of 61,578 treatments were administered to patients and 10,952 of these individual treatments were the administration of arsphenamine. There were discharged as cured, 314, as non-infectious but not cured, 244, as probably cured, 893. Altogether during the 10 months—October 1918 to July 1919—over 230,000 cases were treated at the 267 United States Public Health Service and State Clinics which reported. Many other cases were treated but not reported.

Educational Program.—Perhaps the educational work carried on during the war was the most important part of the campaign because after all the continuation of suitable administrative measures depends upon the support of the community. We have already indicated in our discussion of sex hygiene that the young man or the young woman should be told of the danger of venereal diseases at the right time and in the right way. This can now be more easily done than in the past. The Public Health Service and State Departments of Health have prepared special and admirable pamphlets for different groups and ages. During the war the motion picture "Fit to Fight" prepared specially for men in the service was shown to practically every man in the army and navy. Since then this picture and others like "The End of the Road" have been shown to a large percentage of our civil population. These films have been well made and if shown under the right auspices they are useful and instructing to young men and women. They can best be shown under the supervision of the State or Federal Government, in which case the picture

may be preceded by a talk from a physician or health officer to make certain that the audience approaches the subject in the right frame of mind. It is doubtful whether such films should ever be shown without being under the supervision of some medical or health officer. It is not proposed to use these pictures for boys or girls under 16 years of age.

The public should learn from these sources that syphilis is a communicable disease, that its presence can be determined by clinical examination or by the Wassermann laboratory test upon the blood serum. The disease is now curable by the use of salvarsan and allied products but the course of treatment must extend over three years and must be followed out honestly and completely. The best doctors insist that the marriage of syphilitics should never be sanctioned unless they have undergone three years of thorough treatment and have subsequently been without symptoms for at least one year. Prophylaxis with calomel ointment within 20 hours after exposure is a fairly successful but not a certain preventive against the disease.

We may hope that the serious consideration which has been given this disease in the United States during the past few years will give health authorities a keener appreciation of the seriousness of the problem, that it will make the medical and allied professions more aware of their responsibility in warning the patient against the spread of the disease and in keeping him under treatment until the disease is cured, and that the general public will understand the facts regarding the disease and insist that the practical and common sense medical and legal measures shall be taken for its control.

COMMON COLD

It may seem strange that the common cold should be listed here as the third great health problem but a moment's consideration will show that it is the most widespread of the communicable diseases. It is *continuously pandemic.* Always

and everywhere the common cold is present to a limited extent and certainly no contagious disease enters the dentist's office so often as this one. We pay little attention to the disease because it is not fatal and there are no good figures to show us what a tremendous loss it really produces.

Let us consider merely the economic loss from this disease. Is it not safe to assume that the average workman loses two days a year from a cold? If this is true then thirty million people who are employed in industry lose a total of sixty million days work. If you reckon the average wage as $4.00 a day here is nearly a quarter of a billion dollars lost in wages alone. Add to that the cost of decreased production and the loss from throwing out of employment other people in the same department or depending upon the work of the absentee and the loss becomes truly appalling. And this does not take into consideration the loss of efficiency during the days when the individual works with a cold or the general impairment of health which colds produce; and the figures are for factory workers only.

Are we justified in saying that common cold is not a serious disease merely because it does not produce death? The common cold is an acute infection of the nose, pharynx, tonsils, larynx, trachea or upper bronchi; and how often do neuritis, rheumatic fever, pneumonia and rapidly progressing organic diseases follow these conditions!

The Cause of Colds.—The cold is an infection and not merely a congestion. It is contagious and runs through a family or through a school or through a group of workers just as any other infectious disease. It has not, however, a single cause. There are a variety of bacteria associated with catarrhal infections such as staphylococci, streptococci, pneumococci, the influenza bacillus, the diphtheroid bacillus and the bacillus catarrhalis. Many of these bacteria are normal inhabitants of the mouth and nasal passages and they are doubtless waiting for an opportunity to set up the disease anew when the vitality of the individual is lowered.

Catching Cold.—Many people still have the mistaken belief that drafts produce colds. Of themselves drafts cannot produce infections and a chill is not the time when the infection takes place but rather indicates the period when the cold is becoming more active. When a cool wind reaches the skin of a normal individual his vasomotor system reacts by removing the blood from the skin and thereby lessening the heat lost and the body further reacts by increasing the heat production. Removing the blood from the skin about the face, shoulders and back of the head will congest the blood vessels at the interior. This may increase the watery or serous exudate upon the inner surfaces of the throat and nasal passages, and bacteria, which may be present normally or which have been recently acquired, find an opportunity to develop rapidly on these congested surfaces. Furthermore if the cooling effect is long continued the temperature of the body is reduced and in this way the resistance is lessened. If the vasomotor system of the body is in poor condition bodily adjustments to changes in temperature are less efficient and drafts are more likely to produce injurious effects. It is by improving the vasomotor system that cold baths, physical exercise and vigorous health assist in keeping a person free from common cold.

Conditions which cause a continual irritation in the nose and throat also predispose to colds. Chronic catarrh, enlarged tonsils, polypus, deviation of septum and adenoids are examples. No doubt a dirty mouth is more likely to harbor the bacteria which may produce common cold than a clean mouth. The quality of the air passing over the respiratory passages is also important. Poor ventilation which allows the air to become too dry or dusty will set up undesirable nose and throat irritation. The air should be fresh and of suitable temperature. If the home or work place is too warm the sudden change of going out into the open will congest the breathing passages. It has been pointed out that in the coldest weather it is the passengers in the stuffy carriages of the train

who catch cold and not the fireman and engineer. Arctic explorers have been free from colds while in the far north only to become reinfected by a return to temperate climate where reinfection took place.

Since the organisms which produce cold are almost constantly in the mouth and nose the opportunities for infection are innumerable. Dr. Chapin has stirred the imagination by asking us to consider what would be the result if the secretions from the mouth and nose were of a bright color. If each individual shed from these cavities a different shade of an intense red dye it would be appalling to see how quickly the surroundings would take on a rosy hue. The fingers are constantly going to the mouth and nose and would quickly become a deep red color. The handkerchief would become quickly dyed, we would exchange material with the people with whom we shake hands and the door-knobs, trolley car-straps, our desks, books, and instruments would all acquire the color far too rapidly. Perhaps it would be fortunate if this could happen to us for a day. We would certainly have a revelation as to the amount of care which we should use in preparing and serving our food, and we might wish to abolish the habit of hand shaking.

There are three important rules for the prevention and treatment of colds:

(1) Remember that colds are spread by organisms in the secretions of the nose and throat, and *try to avoid infection.* We should be much more careful in avoiding contact with persons who have colds. We should not let people cough or sneeze in our faces and we should avoid using common eating or drinking utensils. We must educate or train ourselves in habits of sanitation or cleanliness as those words are interpreted under the germ theory of disease.

(2) *Avoid predisposing causes.* Drafts, poor food, extreme fatigue, lack of sleep, and bodily defects lower the resistance of a person so that colds may be acquired more readily. Do

not neglect the duty to yourself of keeping in good physical condition.

(3) *When you feel a cold coming on go to bed.* This may seem a severe remedy but there are many reasons for doing it. Colds are most contagious during the early period and if a person isolates himself in bed he is preventing contagion as well as taking the best possible care of himself. The reconstructive forces of the body work best when a person is resting quietly in bed under proper conditions of temperature and nutrition. The body is rested and strengthened and the danger of increasing the severity of the disease by exposure to cold, damp and fatigue is eliminated. To stay in bed for a day or two when a cold is first coming on is perhaps the best economy of time as well as a "safety first" procedure.

INFLUENZA

In 1890 the United States had a severe epidemic of la grippe or influenza. There were milder recurring epidemics during the next three years and since that time (prior to 1918) we have thought of influenza as a mild endemic disease. There was a fatality rate of about one death in a thousand cases. We have found the influenza bacillus in what seemed like common colds, and we have spoken of the "grippe," "grippy colds" and "bad colds" rather indiscriminately.

In 1918 there began an epidemic of influenza which proved to be the most serious epidemic in the history of the world. The first cases of the great epidemic in America were brought to Boston on an army transport late in the month of August and from this city the disease rapidly spread to all parts of the country. During the winter of 1918 and 1919 there were nearly a half million deaths in the United States attributable to this disease. The influenza was frequently complicated with pneumonia and it was in this complication that the death rate was highest. Instead of losing *one* out of every thousand persons *who had the disease* during this epidemic we lost about

five persons for every thousand people of *our whole population.* It is reported that in India there were five million deaths.

Cause.—It was particularly difficult to combat because we did not and we still do not know the cause. The influenza bacillus was found in a large percentage of the cases but it seemed to many that there must be some other microorganism present. If the disease was due to the influenza bacillus alone the germ possessed a virulence of incomparably greater strength than that of the organism which has been present in the endemic form of the disease. Endemic influenza has presented much the same problem as do common colds. Epidemic influenza has presented an entirely new group of problems. It may be well to summarize some of the facts which have been brought to light from our recent sad experience.

Morbidity and Mortality Rates.—Classifying the 45 cities of the Weekly Health Index into three broad geographical groups the Census Bureau found a variation in the mortality (*Weekly Health Index,* March 1, 1917). In the cities east of the Appalachians the mortality from pneumonia and influenza from September 14, 1918, to March 1, 1919, was approximately 5.6 per thousand; in cities between the Rocky Mountains and the Appalachians 4.35 per thousand; and in those of the Pacific Coast 5.55 per thousand. There were, however, wide differences among individual cities.

To gather further statistics house to house surveys were made by the Public Health Service from the following population groups; New London, Conn., 7,993; Baltimore, Md., 33,-361; certain smaller towns and rural districts in Maryland, 12,669; Spartanburg, S. C., 5,257; Louisville, Ky., 12,602; Little Rock, Ark., 9,920; San Antonio, Texas, 12,534; San Francisco, Cal., 18,682.

The *case incidence* was highest in children from 5 to 14 years old and progressively lower in each higher age group. The ratio of pneumonia cases to total population varied from

6.3 per thousand in Spartanburg, S. C., to 24.6 per thousand in the smaller towns of Maryland. The pneumonia rate showed little correlation with the influenza attack rate. The ratio of deaths to population varied from 1.9 per thousand in Spartanburg to 6.8 in Maryland. The death rate was by no means parallel to the influenza attack rate but was closely correlated to the pneumonia attack rate. The *fatality* from pneumonia was uniformly about 30 per cent except in San Antonio, where it was only 18.5 per cent. The death rate was notably higher in children under one year old, in adults from 20 to 40, and in persons over 60; higher in males than in females and higher in the white than the colored population.

Immunity.—Some investigators believe there is a considerable but not absolute immunity conferred by an attack of the disease. In Baltimore the first canvass was made prior to December 11 and a second canvass was made in January. Among 32,600 people, 724 cases were found to have occurred since the previous survey. Upon an investigation of cases the clinical diagnosis of influenza in both attacks was confirmed in only 26 cases, or 0.37 per cent of the total and even in these cases the diagnosis was necessarily uncertain. It will be seen, however, that there was a very brief period between these studies and the author believes that other figures will soon be available to indicate that no lasting immunity is conferred by an attack of the disease.

Control.—An important investigation by Col. Lynch and Lieut.-Col. Cumming (*American Journal of Public Health*, Jan., 1919) indicates clearly that influenza may be spread by a contamination of eating utensils which are not properly boiled in washing. The investigators compared two groups of troops living under comparable conditions except that in the first group the mess kits were collected and properly washed in boiling water while in the second group there was individual mess kit washing in water which was necessarily below the boiling point. These two groups were about equal in size. In the group having collective tableware washing

there were 33,452 men, among whom there occurred 1710 cases or a *period rate* of 51.1 cases per thousand for the 14 days under consideration. Among the second group of approximately the same size, where there was individual mess kit washing, there were 8208 cases or a period rate of 252. It was shown that "80% of the infections among 66,000 troops were due to unsanitary messing arrangements." Subsequent studies of over 18,000 hotel and restaurant employees showed that there were 85 per cent more cases among those who had eaten from hand washed dishes not disinfected by boiling water. This is clearly a suggestion for sanitary dish washing (immersion in boiling water) in the home as well as in public eating places.

In discussing the administrative control of influenza, Dr. Allen Freeman (paper read at the American Public Health Association meeting in New Orleans, October 28, 1919) stresses the need of further investigation into the nature of influenza. He states that although there is every reason to believe the disease is caused by a virus lodging in the nose and mouth and spread from secretions of the nose and mouth indirectly or through droplet infection these beliefs are not proved by experiments. The paper holds that prompt isolation is important and that educational measures are most helpful. However, the prohibition of public gatherings and the use of masks are not to be regarded as very important means of prevention. Until we can be certain that we know the virus of this disease, vaccination is not sound practice. The procuring of adequate medical and nursing service and the proper care of pneumonia cases are important in reducing mortality.

CHAPTER X

PUBLIC HEALTH ADMINISTRATION

The health of the individual is protected, first, by proper personal hygiene, and second, by the activities of organized government in disease prevention. We are here considering the health administration of the Federal, State and local governments.

Public Health Authority.—The division of the responsibilities for administering public health among National, State, and Municipal governments is dependent upon the relationship which these bodies bear to each other under the Constitution of the United States and the various State constitutions. Ours is a Federal government and each State has supreme power in those questions which affect that State alone. In such matters it may, if it chooses, direct the individual community and it may not be interfered with by the Federal Government. In considering the activities of the public health officials we shall first investigate their powers under the law and then discuss their activities.

FEDERAL PUBLIC HEALTH FUNCTIONS

The National Government has only such powers as are granted to it by the Constitution. In such matters State law must give way but where power is not specifically given to the National Government it is assumed that the power lies with the states. There is no specific mention of any power over the public health in our Federal Constitution but authority is granted "to make all laws necessary and proper for carrying into execution any of the powers placed by the Constitution in the Government of the United States or in any

department or officer thereof.'' And ''power to regulate commerce, levy and collect taxes and carry out treaty agreements'' are specifically granted to the National Government. Certain public health activities are very properly carried on under these broad powers.

The Power to Regulate Commerce.—The first general clause by which the Federal Government has power to regulate public health is the clause giving it power to regulate commerce with foreign countries and among the several states. The words ''commerce'' and ''regulate'' are not defined and their meaning has been gradually enlarged. *Commerce* is interpreted to include not only the active transportation of persons and things from one place to another but also artificial land and water routes, terminals, harbors, vehicles, and the persons, both carriers and shippers, consignees, employers and employed, who are engaged in the active transportation. Commerce embraces purchases and sales and the negotiations entered into in order to lead to sales. Indeed there is a tendency to regard manufacturing as a part of commerce where its regulation is necessary to the effective regulation of what is admittedly commerce.

The power to *regulate* includes not only the right to charter companies and the right to regulate contracts between shippers and carriers, carriers and their employees, between sellers and purchasers, but also the right to prohibit commerce on certain articles, to prohibit certain methods of carrying on commerce and to license those engaged in commerce.

The power of the government through this clause is the power to prohibit, under criminal penalty, the interstate transportation of persons or articles. It includes, therefore, the power of quarantine against persons or things to prevent their entrance from one state to another where such an entry may be judged to endanger the public safety. In commerce with foreign countries the government may take action in the nature of either an embargo or an inspection.

The power of the government to restrict the transportation of an article includes the power to determine whether the article transported falls within the prohibited class and thus provision is made requiring the labeling of articles and the inspection at the place of manufacture of articles intended for interstate transportation as well as for the licensing of persons engaged in their manufacture.

An important use of this power was the enactment of the Food and Drug Law which forbids the transportation from one state to another of adulterated food products and drugs. The law was upheld by the Supreme Court as constitutional. On the other hand, the Child Labor Law which forbade the transportation of goods made in factories where children under 14 years of age were employed, or where there were employed children under 16 years of age who worked more than eight hours a day was not upheld by the Supreme Court. It was declared unconstitutional because it was regarded as an attempt to regulate the methods of manufacture within a state. The transportation of articles manufactured by child labor could not in the nature of things be harmful and therefore the injury to health which resulted was done in the state of manufacture and hence was due to manufacturing and not to commerce.

Taxation.—The second source of power in regulating public health is the power to "lay and collect taxes, duties, imposts, and excises to pay the debts and provide for the common defense and general welfare of the United States." The power to tax is in reality the power to destroy. Congress has in the taxing power a method of protecting public health which naturally lends itself to matters where prohibition rather than regulation is sought. The only limit to this power is the condition that the classification of articles and persons to be taxed must have some reasonable relation to the object sought.

The last revenue bill provided a prohibitive tax on all manufacturers employing child labor. The litigation which is

bound to occur upon this point will undoubtedly determine more definitely the limits of Federal power under the right of taxation. Another example of the taxing power in the interest of public health is the Harrison Act, which regulates the use of drugs by exercising the taxing power.

Defense and Welfare Powers.—The power to "provide for the common defense and general welfare of the United States" is also important. Under this power the government has established a national Public Health Service authorized to assist state health authorities and cooperate with them. Thus, although the United States Government may not interfere with the sanitary work of the states it may have a far-reaching influence on state health administration through its power of appropriating money for health work.

Treaty and War Powers.—Congress, no doubt, may exercise legislative power in carrying out the provisions of treaties. Such powers, in the past, however, have not been largely exercised and their limits are not definitely set. It should also be remembered that in the District of Columbia, territories and reservations the Federal Government has complete powers, and that in time of war its power to raise and support armies and to provide a navy carries with it the power to do whatever is necessary to protect the health of soldiers and sailors, even within state lines.

The United States Public Health Service.—The most important branch of the Federal Government in its relation to health is the Public Health Service. The following concise statement regarding its development and organization was supplied by the Chief of the Section of Public Health Education, Dr. Charles Bolduan, in a letter written December 6, 1919:

The Public Health Service dates back to the end of the Eighteenth Century when, in 1796, steps were taken for providing medical and surgical relief to merchant seamen. At first this was financed by a per capita tax collected from the seamen, the funds being handled by the collectors of customs in the various ports. Subsequently this was

changed into a tonnage tax, collected through the same channels. This explains why the marine hospital work (the precedent of the present U. S. Public Health Service) came to be lodged in the Treasury Department, for the collection of customs was naturally a branch of the Treasury Department's work. With the enormous growth of the American Merchant Marine in the first half of the Nineteenth Century this method of providing for the merchant marine was found to be inadequate and the government, therefore, established "marine hospitals" at various important points.

In an effort to guard against the introduction of dangerous pestilential diseases from without it was natural that the officers of the marine hospitals, stationed as they were at the important ports of entry, should come into close relation and take an active interest in maritime quarantine matters. In addition to this, the repeated introduction of yellow fever into the southern states and the alarm occasioned thereby caused repeated calls to be addressed to the Federal Government to take charge of control measures at the infected points in order to prevent the spread of disease to other points of the United States. There being no special Federal health agency, these calls were naturally referred to the United States Marine Hospital Service. More and more, therefore, this Service began to undertake federal public health activities, a fact which was recognized by Congress when, in 1902, it changed the name of the Service to the United States Public Health Service and Marine Hospital Service. More recently still, in 1912, the name was still further changed to its present designation, namely the United States Public Health Service.

The United States Public Health Service is a bureau in the Treasury Department. At its head is the Surgeon-General. He is assisted by a staff of Assistant Surgeon-Generals. Most of these have charge of important functional divisions. As at present organized, the work is carried on under the following divisions:

Division of Personnel and Accounts. (As its name implies, it has to do largely with matters of internal administration.)

Division of Marine Hospitals. (In addition to caring for merchant seaman, this division has charge of all the medical and surgical relief work for discharged soldiers, sailors, marines and nurses who are beneficiaries under the War Risk Insurance Act.)

Division of Maritime Quarantine. (This conducts almost all the maritime quarantine stations for the United States and the insular possessions.)

Division of Domestic Quarantine. (This controls the important field relating to the control of diseases through the interstate traffic.)

Division of Scientific Research. (This is a large division engaged

in studying the diseases of man through field investigations and laboratory work.)

Divisions of Sanitary Reports and Statistics. (This division collects information regarding the prevalence of communicable diseases, disseminates it through publications and otherwise to Health Officers and Sanitarians throughout the country.)

Division of Venereal Diseases. (This recently created division was established by Congress primarily to safeguard the nation's manhood against the ravages of venereal infection.)

Section of Public Health Education. (A recently established activity for promoting public health through popular health education.)

The personnel below the rank of the Assistant Surgeon-General consists of Senior Surgeons with a rating corresponding to that of Lieutenant-Colonel in the army, Passed Assistant Surgeons with the rating of Captains, Assistant Surgeons with the rating of 1st Lieutenants, Scientific Assistants with the rating of 2nd Lieutenants, Pharmacists, Orderlies, Technicians, and other attendants with the rating of noncommissioned officers. These grades are largely for the convenience of these Federal officials in order to determine relative rank when sitting upon boards or commissions with army and navy officers. The Public Health Service is a civilian and not a military branch of government, although during the world war it was declared a branch of the military service by the President of the United States, being continued under its usual organization.

The functions of the Public Health Service have been described by Assistant Surgeon-General McLaughlin as of four kinds. *Police duties* are first mentioned. These include the maintenance of quarantine and the prevention of the spread of disease from one state to another. The second activity is that of *investigation*. With increased appropriation from Congress the Hygienic Laboratory of the Public Health Service at Washington should be made a big center of research in preventive medicine, for it is obviously fitting that the National Government should undertake the solution of the nation's great disease problems. The third activity is that

of *demonstration.* With the cooperation of the state and local agencies, special pieces of work may be undertaken to prove the value of rural sanitation and other health measures. The fourth activity is that of the *coordination* of state and local activities in various parts of the country in order "to secure a synchronous attack upon any disease with uniformity of method over the entire area of the United States." For example in the national campaign against venereal diseases Congress appropriated one million dollars under the Chamberlain-Kahn bill and under the cooperating agency of the Public Health Service the various states waged a uniform and successful campaign.

The Public Health Service is the principal and most important health agency of the Government. It has been accredited with all the powers that Congress can give it for doing health work. The nature of its activities is limited by the Constitution and the extent of its activities is limited by the failure of Congress to give it sufficient appropriations. Perhaps it is also handicapped by being a semimilitary organization; because many people mistake the brown or blue uniforms for those of the army or navy. The people regard health officials as "their servants" and object to the "red tape" and "army methods" of the Service which sometimes, perhaps of necessity, lacks the personal consideration and tact of local health organizations.

Other Federal Health Agencies.—There are two other departments in the Federal Government which are doing rather extensive health work, the Children's Bureau in the Department of Labor and the Bureau of Education in the Department of the Interior. Many of the departments of the government are doing lesser amounts of health work and much is apparently being lost through lack of centralization and coordination. Attempts have already been made to secure a central health administration and this movement has doubtless been strengthened by the recent organization of a Ministry of Health in both England and Canada.

STATE HEALTH FUNCTIONS

Under our form of government each state bears the responsibility for its health conditions and upon the state legislature, as the supreme power of the state, this responsibility primarily rests. The Federal Government has no right to interfere in those matters which affect only the state itself, but the towns and municipalities within the state are all bound to enforce the state law. The legislators, limited only by the constitution and responsible only to the electorate, are supreme in their power to determine what health regulations shall be made and what official organization shall be provided by each municipality and by the state at large to administer public health. Since public health administration within the state is directly dependent upon the law it may be profitable to consider the principles of health legislation at this point.

Public Health Laws.—Public health laws may be divided into two groups; those statutory laws creating the public health *organization,* and those, statutory and otherwise, which govern public health *administration.*

The first law providing for health organization was the Massachusetts law of 1797 establishing Boards of Health for towns and giving each board power to "make such regulations as it judges necessary for the public health and safety." Since then the other states have made similar laws, the last enactment being that of Nevada in 1905, while many of the large cities have had special sanitary provisions incorporated in their charters. The type of local organization has varied in different states depending upon whether the administrative unit of government was the township or the county. The local authorities are required to keep the state authorities informed as to the sanitary conditions of their districts and in all cases local health ordinances must not contravene the laws of the state. Since 1855 each state has enacted a law creating a State Board of Health or its equivalent.

In the legal side of public health administration, common

and constitutional as well as statutory laws are involved. The *common law,* or lex non scripta, consists of the court decisions made in the course of administering justice. The decision of a lower court or the opinion of an attorney has little value as a precedent, but the decision of the supreme court is binding upon subordinate courts until overruled. *Statutory laws* are enacted by legislatures upon the basis of common law and their official interpretation has the force of additional legislation.

Coincident with the growth of common law there is usually the establishment of *institutions* such as quarantine. These institutions, however, may become antiquated and abandoned as the quarantine of yellow fever. When conflicting with either statutory or constitutional law they are not lawful.

All authority for the protective operations of government including the preservation of public health is derived from what is known as *police power,* an inherent function of government. In its exercise we find cases where there is sanction for otherwise illegal acts, such, for example, as the violation of personal or property rights to protect the safety of the people in great epidemics.

The use of *license* is essentially police in nature. A license may be issued with a slight fee as in licensing milk dealers where it is the license rather than the fee which serves to restrict or regulate the business. On the other hand, the issuance of licenses at a prohibitive cost has been a reasonable use of police power in restraining the liquor traffic. A temporary license, or one which covers a single act, is ordinarily called a *permit.*

Where a health officer is given *power of discretion* he may do any act within that discretion, and all that he does will be held to have been done with the express authorization of law. Should the health officer abuse his power of discretion he is amenable to prosecution, but the act to be criminal must be wilful and corrupt, and proof of this rests upon the complainant. If the officer has deviated from his legal authority

through a mistake in interpreting his power or a mistake of fact in applying the law he is liable as a private wrongdoer and responsible in such damages as may be proved.

An officer is not subject to a private action for neglect of an exclusively public duty even to a person specially injured thereby, and in some cases even though the act were unlawful and malicious. If discretion be left entirely to the administrative officer, there is no way in which he can be forced to act. In the enforcement of statutory law, an officer is subject to mandamus and also to probate action whenever he shall deviate from his prescribed limits of duty.

Some laws like quarantine are mandatory as to action, but discretionary as to method. In court proceedings if the law be specific the only questions which may arise are those of fact; if discretionary, questions of fact, reasonableness and extent of discretion may be presented.

A city's administration depends upon fixed rules. They are either written *regulations* or unwritten *usages*. When a penalty is attached to a violation of the rules or regulations of the board of health, such rules must be published and due notice given before they can be made effective. Violations of the regulations may be punished by indictment, action being uniformly brought in the name of the town or city.

Injunction is applicable to prevent executive action, the taking or impairment of property or the creation of nuisances. It is not used to direct or restrain the exercise of discretionary authority.

A public health *nuisance* is a state of affairs which is dangerous to public health. Obviously a thing may be a nuisance under either common or statutory law. In a case of exigency the health authorities may summarily abate the nuisance, but if the owner of the property cannot get a formal trial before the abatement he is entitled to a hearing afterward. The burden is then upon the authorities to justify their action.*

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*For an extensive discussion of public health legislation see *U. S. Public Health Bulletin No.* 64 published in August, 1912, "*Organization, Powers and Duties of Health Authorities*"; also "*Legal Principles of Public Health Administration*, by Henry B. Hemenway.

State Health Administration; Organization.—Turning now to a consideration of state health administration we find that the oldest type of organization placed the administration of public health in the hands of a Secretary of the State Board of Health. He was the executive officer and his activities were guided by the policy and wishes of the Board. Recently many states have changed their type of organization from a State Board of Health to a State Department of Health under the direction of a Commissioner with an Advisory Council. New York initiated this movement with its law of 1912. Massachusetts soon followed suit with a similar law, containing a few modifications and since then Maine, New Jersey, Connecticut, California, Ohio and several other states have adopted some form of the New York-Massachusetts plan.

The organization of the State Department of Public Health, of Massachusetts, July 1, 1920, is as follows:

Working under the advice of the Public Health Council is the Commissioner of Health whose organization is made up of the following divisions:

1. Sanitary Engineering

Director and Chief Engr.	1
Asst. Engineers	12
Draftsman	1
Clerical	5
Messenger	1

Activities

Advice to cities and towns in regard to water and sewage problems.

Field surveys and investigations necessitated thereby. Special Engineering projects imposed by the General Court.

2. Water and Sewage Laboratories

Director and Chf. Chemist	1
Asst. Chemists	5
Biologist	1
Laboratory Asst.	1
Clerical	2

Lawrence Expt. Sta.

Asst. Chemist	1
Bacteriologist	1
Laboratory Asst.	1
Filter Attendant	1
Laborer	1

Activities

Investigation of water, sewage and trade waste problems.

3. Food and Drugs

Director and Analyst	1
Assistant Analysts	4
Food and Drug Inspectors	4
Veterinary Inspectors	3
Cold Storage Inspectors	2
Clerical Inspectors	3
Messenger	1

Activities

Examination of milk, food and drugs. Dairy Inspection.
Cold Storage Inspection.
Slaughtering Inspection.
Food Economics.
Drug Addictions.
Patent Medicine Frauds.
Arsphenamine Production.

4. Administration

Clerical	6
Messengers	2

Activities

Correspondence.
Financial.
Statistical.
Records.

5. Communicable Diseases

Director	1
Epidemiologist	1
Dist. Health Officers	8
Bacteriologist	1
Asst. Bacteriologist	2
Laboratory Asst.	2
Clerical	6

Sub-division of Venereal Diseases

Chief	1
Epidemiologists	2
Clerical	4
Inspector	1
Educationalist	1
Subsidized Clinics	16

Activities

Prevention of all Communicable Diseases, except tuberculosis.

6. Hygiene

Director	1
Asst. to Director	1
Health Instructor	1
Field Supervisor	1
Clerical	2
Dental Hygienist	1
Instructor in Foods	1

Sub-division of Public Health Nursing

Chief	1
Nurses	3

Activities

Infant Mortality:
Child Hygiene.
Industrial Hygiene.
Rural Hygiene.
Health Instruction.

7. Biologic Laboratories

*Director	1
Asst. Directors	2
Expert Asst.	1
Laboratory Assts.	5
Other Assts.	3
Technician	1
Clerical	1
Janitor	1

Activities

Manufacture and Distribution of Diphtheria Antitoxin, Smallpox and Typhoid vaccines. Antimeningitis serum. Wassermann tests for Syphilis.

*Part time.

8. Tuberculosis (Sanatoria)

Director	1
Clerical	4
Visitor	1
Superintendents	4
Hospital Staffs	??

Activities

Prevention of Tuberculosis and Treatment in Sanatoria.

The work to be done is practically the same no matter what the type of organization although naturally the extensiveness of the work done by each state varies with the size of its health appropriation, the efficiency and number of its personnel and the extent to which the state supervises local health administration. We shall use the new type of organization in describing state health activities, because it is already becoming the common type of organization and because it lends itself well to a description of health functions.

The essential features of the New York State Department of Health are set forth in the law which created it. There are provisions for a Commissioner, a Public Health Council, a Sanitary Code, the employment of District Health Officers, and the creation of various Divisions.

The *Commissioner* is appointed for a term of six years and must have had ten years experience in the practice of his profession and in public health duties. The Deputy Commissioner is appointed and at pleasure removed by him. The duties of the Commissioner include a general supervision of the health activities of the State, the enforcement of public health laws and the sanitary code, the study of health con-

ditions, and the keeping of vital statistics, while his powers include the right to modify a local ordinance and the right of entry which he may delegate to any of his employees.

The *Public Health Council* is composed of the Commissioner and six other members, three of whom are physicians, appointed by the Governor for a term of six years and receiving a salary of $1000.00 per year over and above necessary travelling expenses. The Council has no executive or administrative duties but acts in an advisory capacity to the Commissioner and may at any time offer suggestions.

The *Sanitary Code*, consisting of rules and regulations affecting the security of life or health, is enacted by the Public Health Council. The provisions of this Sanitary Code have the force and effect of law in all parts of the State and are only restricted in that they shall not discriminate against any licensed physician. These regulations are filed with the Secretary of State. In enforcement they supersede any local ordinances which may be inconsistent with them, and include besides sanitary regulations a statement of qualifications for Directors of Divisions, Sanitary Supervisors, Local Health Officers, and Public Health Nurses.

It is to be noted that the legislature has delegated a limited amount of "law-making power" to the Public Health Council. In such a case the delegation of power is judicious and progressive, for only a body of experts is qualified to work out the details of public health regulations.

It is definitely provided that there shall be in the Department of Health nine *Divisions*, namely:

1. Division of Administration.
2. Division of Sanitary Engineering.
3. Division of Laboratories and Research.
4. Division of Communicable Diseases.
5. Division of Vital Statistics.
6. Division of Publicity and Education.
7. Division of Child Hygiene.

8. Division of Public Health Nursing.
9. Division of Tuberculosis.

A division of Venereal Diseases has since been added.

Sanitary Districts are formed by the Health Commissioner, and District Health Officers are appointed by him. It is their duty to keep in touch with local health officers, aiding them when necessary, to make special surveys, hold conferences, adjust local questions of dispute, study mortality, promote the registration of births, inspect camps and Indian reservations, enlist physicians for emergency service, and assist in public education, and the enforcement of the sanitary code.

Administrative Functions.—Let us consider briefly the activities of the various divisions of the State Department of Health.

One of the first recognized duties of the state has been the collection of *vital statistics.* This includes the recording and analyzing of data concerning deaths, births, marriages, population, and diseases. The keeping of vital statistics is the bookkeeping of a state by which it keeps a record of changes in the population, which represents its great item of wealth. Just as an industrial concern keeps an account of its material assets and liabilities so the state must keep a record of its human assets and liabilities. It must know whether it is gaining or losing and where and how. If disease is to be prevented and lives are to be saved careful records must be kept to show where, when and how diseases and deaths are occurring.

The recording and interpretation of vital statistics is a science in itself and highly trained *vital statisticians* are employed for this work. The layman may not be particularly interested in the methods of interpreting statistics but he will at least wish to know what is meant by the most commonly computed rates.

The *birth rate* is the number of births annually per thousand population. The crude *death rate* is the number of

deaths annually per thousand population. We also have what are termed *specific death rates* which state the number of deaths per thousand or per 100,000 population for specific diseases. For example a low typhoid death rate is 4.3 per 100,000.

Another important figure is the *morbidity rate* which is the number of cases of specific disease per thousand population (sometimes expressed as the number per 100,000 population). The *fatality rate* is the number of deaths from a specific disease per 100 cases (the per cent fatality). We say, for example, that among pneumonia cases the fatality rate was 33.

By such figures our "life and death bookkeeping" shows us how we can tell just where our various communities stand in the matter of life-saving and health. When we realize that such figures show whether we live in a safe and healthy community or a dangerous and sickly one, the statistics of our state and local health officers become most interesting reading. The registration of births, marriages and deaths is also important for legal, social and property rights.

The Division of Administration, which is presided over by the Health Commissioner, includes a supervision over the work of the district health officers, accounts, salaries, expenditures and other administrative details.

An increasingly important division is that of *Public Health Education.* It embraces the publicity work of the State Department of Health, such as the circulation of the reports issued by the department, publicity work through the newspapers, the showing of health exhibits in various parts of the state, the issuing of pamphlets and instructive material to school children and to people generally, lectures, moving pictures and all of the numerous and valuable activities by which the state health department places before the people the important principles concerning the care of the health.

The functions of the *Division of Sanitary Engineering* are to safeguard the water supplies and to insure proper waste

disposal throughout the state. Such a department maintains facilities for water and sewage analysis and is able to furnish the advice of an expert Sanitary Engineer in any problem of water supply and waste disposal. These problems will be considered in a special chapter.

The special duties of the *Division of Communicable Diseases* include activities in controlling and limiting the spread of various communicable diseases. An epidemiologist is usually attached to the Department, who promptly investigates incipient epidemics enabling the division to take more prompt and intelligent steps in restricting the disease.

The *Division of Child Hygiene* maintains a personnel of trained workers in subjects of infant and child welfare, who make surveys, develop special state and local campaigns to improve the hygienic conditions of maternity, infancy and childhood and cooperate with private child-health agencies through the state.

The *Division of Public Health Nursing* determines the qualifications of the public health nurse, employs a corps of nurses to assist district health officers and broadens the usefulness of such nurses as are employed by various communities in the state through its assistance and cooperation.

The *Division of Laboratories and Research* provides free laboratory diagnosis of communicable diseases, prepares and distributes vaccines and antitoxins to the medical profession and carries on public health research.

The *Division of Tuberculosis* directs the operation of State Tuberculosis Hospitals and Sanatoria, and assists local communities to combat the disease by investigating conditions and showing the value of early reporting, dispensary service, milk control and other measures.

Nearly all of the states have recently established a *Division of Venereal Diseases* as a result of the campaign waged by the Federal Government subsequent to the passage of the Chamberlain-Kahn Act which offers temporary financial assistance to states in the controlling of venereal diseases provided

proper regulations and a suitable organization are established.

The organization of a state health department is more or less elastic and not all of these divisions are present in every state. New divisions may be established and old divisions may be abolished to fit the need of the occasion.

LOCAL HEALTH ADMINISTRATION

Authority.—Before discussing local health administration it may be well to say something about the division of authority between the state and local governments since their relationships are widely varying. In Pennsylvania for example there is a centralized system. The local organization is under the control of the state organization. In Massachusetts the Legislature has given to the state organization only the power to *advise and investigate* with no direct control over the local health authorities. In every state the supreme authority is the state legislature and it can do as it sees fit in giving power to the state organization.

There are dangers in either of the extremes mentioned. If the State Department of Health has power over every local health officer it must accept the responsibility for his activities and the townspeople have an opportunity to blame the state department if anything goes wrong. On the other hand, if the State has no power over local health officials, dangerous conditions may remain uncorrected because of inefficient and careless local administration. We are perhaps tending toward the more centralized system in the country as a whole but it would seem that the system which allows the state department limited but not complete control over local authorities or additional power in emergencies is preferable to either extreme. In some states, legislation is being enacted giving the state department power to administer health in any community when the welfare of other communities in the state may be endangered or injuriously affected. For example, if the quarantine measures of a town are insufficient the state

may step in and make its regulations more strict. This sort of law leaves the responsibility for community health with the local or municipal officials but gives the state power to protect the health of the whole state whenever it may be endangered by local inefficiency.

Local Health Organization.—In any case the major duty of enforcing public health law and maintaining healthful conditions is with the town or the city. Throughout the country there is a fairly uniform local health organization which consists of a Board of Health with a Health Officer or an Executive Secretary. Upon the Health Officer there rests the responsibility of administering health and upon the Board of Health there rests the responsibility of directing health activities. The above discussion of public health laws describes the health officer's responsibility and his powers of discretion regarding them.

There is a tendency in some places to place responsibility upon the local health officer instead of leaving it with the board of health. In some states the health officer may be appointed to replace the board of health and in Massachusetts there has recently been legislation allowing Local Health Departments to be formed—a type of organization similar to that of the state. Here a local Health Commissioner is appointed with an advisory committee. This sets the responsibility upon the health officer but gives him the benefit of advice and support from a committee or council.

The activities of a local health department are many and varied. It is its duty to enforce all of the state laws regarding health and disease, and to enforce in addition such ordinances or local regulations as may be in effect and related to public health.

An important duty of the local department is the maintenance of a *public health laboratory* where laboratory diagnoses for infectious diseases may be made and where examinations of the water, milk, butter, vinegar and foods are carried out. Laboratories in small communities usually begin

with the examination of water and milk, and then add diagnoses for diphtheria, tuberculosis, septic sore throat, syphilis and other infectious diseases. In addition such a laboratory often makes tests for the purchasing department of the city, analyzing flour, coal and other substances.

Other activities include the isolation and quarantine of infectious diseases, subsequent disinfection where necessary, the abatement of nuisances, the supervision of hotels and restaurants, a supervision over sewage and garbage disposal, the supervision over housing conditions, and the administration of special activities such as public health nursing, infant welfare, city hospitals, the control of epidemics, the collection of vital statistics, the making of regular reports to state department of health, and many other matters. The problems of water and food supplies, milk control, and waste disposal will be considered in special chapters as will the subject of school hygiene.

The Health Officer.—From such a list of activities it is obvious that public health administration involves a variety of tasks. The local health officer must know the fundamentals of sanitary engineering or sanitation and the important facts of hygiene. By training the sanitary engineer or the physician is best adapted for this type of work, but either should have a supplementary training. Public health administration is a distinct calling demanding a knowledge of a different group of subjects than go to make up any other profession. In this country we are rapidly learning that the public health officer must be a specially trained man and the number of men with special training in public health is rapidly increasing.

Unofficial Health Activities.—There are many national health organizations in the United States and many local health societies interested in specific or general health problems. It seems reasonable that the function of these private health organizations—and it is a useful function—is to develop those phases of health activities which the health department of a community is not yet ready to handle or which it cannot

well handle because of the particular problem involved. For example, cancer research cannot be carried out by the individual community, it might be done by the U. S. Public Health Service but excellent work may be done by a society specifically interested in the problem. Activities like the prevention of tuberculosis, which would reasonably fall under the work of the organized health authorities, should be cared for by private organizations to that extent to which the local community is not able to handle the problem.

The society of professional public health workers is the American Public Health Association. It includes not only the majority of people professionally engaged in public health but an increasingly large number of people with special public health interests. Its official organ is the *American Journal of Public Health.*

Other societies and health organizations of national importance include: *The American Red Cross,* Department of Health Service, Washington, D. C.; *The American Association of Industrial Physicians and Surgeons,* Harrisburg, Pa.; *The American School Hygiene Association,* Albany, N. Y.; *The American Social Hygiene Association,* 105 West 40th St., New York City; *The American Society for the Control of Cancer,* New York City; *The Child Health Organization,* New York City; *The International Health Commission,* New York City; *The Life Extension Institute,* New York City; *The National Child Welfare Association,* New York City; *The National Committee for the Prevention of Blindness,* New York City; *The National Committee for Mental Hygiene,* New York City; *The National Committee on Malaria,* Birmingham, Alabama; *The National Organization for Public Health Nursing,* New York City; *The National Tuberculosis Association,* Baltimore, Md.; and *The Russell Sage Foundation,* Battle Creek, Michigan.

CHAPTER XI

FOOD CONTROL

Thus far we have considered food from the standpoint of diet. Under food control we shall consider the adulteration and sanitation of foods.

FOOD ADULTERATION

Cost of Adulteration.—It might be said that the prevention of food adulteration is more for the purpose of protecting the pocketbook than for protecting the health. The fraud practiced in food adulteration may sometimes be harmless but, if the adulteration reduces the nutritive quality of a food and adds some poisonous or infected substance the culprit who practices food adulteration not only robs the consumer but attacks his health.

Some people have the mistaken impression that almost all food is adulterated. Although the amount of adulteration varies in different states according to the nature of the Pure Food Law and the efficiency of law enforcement, still the foods which are adulterated are greatly in the minority. Considering the country at large it has been estimated that 15 per cent of the food consumed is adulterated. If this is true, based on an estimate of a $3.00 weekly expenditure per capita, the people of the United States are paying about two and a half billion dollars a year for adulterated, low grade or inferior food. If we accept the figures of experts who estimate that 2 per cent of adulterated food is injurious to health we find that the American people are paying yearly over $46,000,000 for food which actually brings them definite physical injury. Comparing present conditions with expert studies made several years ago it appears that Massachusetts saves over a mil-

lion dollars for the public annually by the enforcement of the Pure Food Law.

Nature and Cause of Adulteration.—Food adulteration has now become a highly specialized art. Mixing sand with sugar and making milk out of chalk are not practiced because the detection of such simple fraud is too easy. The man who adulterates food now employs the skill of the chemist and an ingenuity equal to that of the theater "make-up man" in preparing his products. Coffee has been found which consisted of molasses and flour molded into the shape of coffee berries. American cotton-seed and peanut oil from the southern states have been sent abroad and refined then returned to us as pure Mediterranean Olive Oil. It is only by combating the craft of the manufacturer with the skill of the trained analyst that this type of food adulteration can be detected.

Keen competition and the desire for greater profits are important in causing food adulteration. People demand goods out of season and foods from distant parts of the world at cheap prices. The American wants goods done up in fancy packages, stamped with foreign labels, and served in an extravagant fashion. It is no wonder that many food manufacturers have discovered with Barnum that "the public likes to be humbugged."

Pure Food Laws.—It is not the purpose of a Pure Food Law to prohibit the making of cheap foods or even of second quality foods, but it does insist that these foods shall be sold for what they really are and not passed off upon the public for first quality materials. It is good to have second quality foods in the market if they are clean and wholesome because they are inexpensive. For example, catsup which is made largely from tomato skins, may be nearly as good as that made from the fleshy part or inside of the tomato, provided that the material is properly washed and sterilized; for the difference in food value in a condiment is not important. What we wish to prevent is the use of dirty tomato skins prepared in an unsanitary manner or the sale of second grade

catsup under misleading labels. The public is entitled to know what it is buying.

According to the Federal Pure Food and Drug Act which was passed in 1906 a substance is considered adulterated:

(1) If a substance has been mixed with it to reduce the quality or strength. (Cocoa shells mixed with cocoa or chocolate, or watered milk.)

(2) If any substance has been substituted wholly or in part. (Cottonseed oil for olive oil, cane sugar for maple sugar.)

(3) If a valuable constituent has been wholly or partly abstracted. (Skimmed milk.)

(4) If it is mixed, colored, powdered, coated or stained in any manner whereby inferiority is concealed. (Lemon extract colored with a yellow dye, bleached flour.)

(5) If it contains any added poisonous or any other added ingredient deleterious to health. (Formaldehyde, arsenic, lead, salicylic acid, boric acid or benzoates.)

(6) If it consists in whole or in part of a filthy, decomposed or putrid animal or vegetable substance, or any portion of an animal unfit for food or if it is the product of a diseased animal, or one that has died otherwise than by slaughter. (Oysters contaminated with sewage, wormy figs, embalmed beef, etc.) [Under this clause reasonable sanitary requirements can be enforced.]

The reason certain foods continue to be adulterated in spite of this law is because the adulteration is so difficult to detect. For example, the sugar of the maple is identical chemically with cane sugar and it has been impossible to detect the fraud. The result is that more Vermont maple sugar is made outside the state than all the trees in Vermont could produce. New "Vermont maple sugar" appears in the market long before the sap starts in the maple groves of New England. A Congressional Committee was once told of the experience of a Chicago firm which had sent to the trade 150 barrels of pure maple syrup. Of this 147 barrels were returned with the

complaint that it was too strong. Mixed with cane syrup this same lot was again sent out and only praise was had from the buyers.

Misbranding.—The Food and Drugs Act requires that no drug or article of food shall be falsely labelled as to its contents or as to the state or country in which it is manufactured or produced. A food is deemed to be misbranded:

(1) If it be an imitation of or offered for sale under the distinctive name of another article.

(2) If it be labeled or branded so as to deceive or mislead the purchaser, or purport to be a foreign product when not so, or if the contents of the package as originally put up shall have been removed, in whole or in part, and other contents shall have been placed in such package, or if it fail to bear a statement on the label of the quantity or proportion of any morphine, opium, cocaine, heroin, alpha or beta eucaine, chloroform, cannabis indica, chloral hydrate, or acetanilide, or any derivative or preparation of any such substances contained therein.

(3) If in package form, and the contents are stated in terms of weight or measure, they are not plainly and correctly stated on the outside of the package.

(4) If the package containing it or its label shall bear any statement, design or device regarding the ingredients or the substances contained therein, which statement, design or device shall be false or misleading in any particular.

Law Enforcement.—The Federal Food and Drug Act applies only to foods imported or for interstate shipment. For such food products inspections are made and enforcement is secured by the United States Department of Agriculture. The purity of foods sold within the state is controlled by special state laws and these laws are enforced by state officials. Massachusetts has long maintained an efficient Division of Food and Drugs under the State Department of Health. The samples are collected in various parts of the state by inspectors, each sample is numbered by the inspector who places it in a locker in the partition wall of the laboratory. The inspector himself never enters the laboratory but opens the locker from the outside. Later the locker is opened from the

inside by the laboratory technician and an analysis is made, the report being rendered on the basis of the number used. In this way every suspicion of collusion between the inspector and analyst is avoided.

The state laws are usually similar to the Federal Food and Drug Act but frequently include additional regulations regarding special foods like milk, butter, sausages, etc. The state which fails to make and enforce suitable laws is in a particularly unfortunate condition because large food manufacturers dump poor products upon it.

Special standards for foods like milk, butter and vinegar may also be obtained by municipal ordinance and such foods may be examined in the city public health laboratory. The most common local ordinance is that governing the sale of milk, the skimming or watering of which is determined by a variation from the normal proportion of the constituents produced by such a process. The composition of normal milk is as follows: Sugar 4.7% ; fat 3.8% ; total solids, 12.8% ; refractive index, 37.5; solids not fat, 9%; specific gravity, 1.032; protein, 3.6% ; ash, 0.7%.

FOOD SANITATION

The three most important problems in securing clean food involve the sanitation of milk, meat and prepared food supplies.

Milk.—Milk is used in enormous quantities as a food. Parker believes (*City Milk Supply*, by H. M. Parker, McGraw-Hill Book Co., 1917) that about 5.16 billion pounds of market milk are consumed in this country annually. This means that the average American consumes his own weight in market milk every year. Of course, children use relatively more than adults. The total quantity of milk used in the United States including milk which is manufactured into butter, cheese, and other materials is estimated to be 77.4 billion pounds per annum. This is about 750 pounds per person.

OFFICIAL DAIRY SCORE CARD

Owner or lessee of farm..

P. O. Address.. County..................................

Total number of cows..................Number milking..................Gallons of milk produced daily..........

Product is sold by producer in families, hotels, restaurants, stores, to.............................. dealer.

For milk supply of..

Permit No..........................Date of inspection.., 191

Equipment	Score: Perfect	Score: Allowed
COWS		
Health	6	....
Apparently in good health............1		
If tested with tuberculin within a year and no tuberculosis is found, or if tested within six months and all reacting animals removed 5		
(If tested within a year and reacting animals are found and removed, 3).......		
Food (clean and wholesome).............	1	....
Water (clean and fresh).................	1	....
STABLES		
Location of stable......................	2	....
Well drained..........................1		
Free from contaminating surroundings..1		
Construction of stable..................	4	....
Tight, sound floor and proper gutter....2		
Smooth, tight walls and ceiling.........1		
Proper stall, tie, and manger..........1		
Provision for light: Four sq. ft. of glass per cow.	4	....
(Three sq. ft., 3; 2 sq. ft., 2; 1 sq. ft., 1. Deduct for uneven distribution.)		

Methods	Score: Perfect	Score: Allowed
COWS		
Clean	8	....
(Free from visible dirt, 6.)		
STABLES		
Cleanliness of stables..................	6	....
Floor 2		
Walls 1		
Ceiling and ledges......................1		
Mangers and partitions..................1		
Windows 1		
Stable air at milking time..............	5	....
Freedom from dust.......................3		
Freedom from odors......................2		
Cleanliness of bedding..................	1	....
Barnyard	2	....
Clean 1		
Well drained 1		
Removal of manure daily to 50 feet from stable	2	....
MILK ROOM OR MILK HOUSE		
Cleanliness of milk room................	3	....

Bedding	1	....
Ventilation	7	....
Provision for fresh air, controllable flue system ... 3		
(Windows hinged at bottom, 1.5; sliding windows, 1; other openings, 0.5.)		
Cubic feet of space per cow, 500 ft. ... 3		
(Less than 500 ft., 2; less than 400 ft., 1; less than 300 ft., 0.)		
Provision for controlling temperature ... 1		
UTENSILS		
Construction and conditions of utensils	1	....
Water for cleaning	1	....
(Clean, convenient, and abundant.)		
Small-top milking pail	5	....
Milk cooler	1	....
Clean milking suits	1	....
MILK ROOM OR MILK HOUSE		
Location: Free from contaminating surroundings	1	....
Construction of milk room	2	....
Floor, walls and ceiling ... 1		
Light, ventilation, screens ... 1		
Separate rooms for washing utensils and handling milk	1	....
Facilities for steam	1	....
(Hot water, 0.5.)		
Total	40	....

UTENSILS AND MILKING		
Care and cleanliness of utensils	8	....
Thoroughly washed ... 2		
Sterilized in steam for 15 minutes ... 3		
(Placed over steam jet, or scalded with boiling water, 2.)		
Protected from contamination ... 3		
Cleanliness of milking	9	....
Clean, dry hands ... 3		
Udders washed and wiped ... 6		
(Udders cleaned with moist cloth, 4; cleaned with dry cloth or brush at least 15 minutes before milking, 1.)		
HANDLING OF MILK		
Cleanliness of attendants in milk room	2	....
Milk removed immediately from stable without pouring from pail	2	....
Cooled immediately after milking each cow	2	....
Cooled below 50°F.	5	....
..(51° to 55°, 4; 56° to 60°, 2.)		
Stored below 50°F.	3	....
(51° to 55°, 2; 56° to 60°, 1.)		
Transportation below 50°F.	2	....
(51° to 55°, 1.5; 56° to 60°, 1.)		
(If delivered twice a day, allow perfect score for storage and transportation.)		
Total	60	....

Equipment .... + Methods .... = ... Final Score

Note 1.—If any exceptionally filthy condition is found, particularly dirty utensils, the total score may be further limited.

Note 2.—If the water is exposed to dangerous contamination, or there is evidence of the presence of a dangerous disease in animals or attendants, the score shall be 0.

*Alternate. If the milk is pasteurized by the holding process, score 5.

It is difficult to keep milk in a sanitary condition because it is not a clear fluid but a suspension which hides dirt readily. It is a good medium for bacteria to grow in, so that they rapidly increase unless the milk is kept at a low temperature. Moreover, milk must be produced at a considerable distance from the point where it is finally used. Some of our large cities get milk from farms 300 miles distant. And it is particularly important that it should be kept clean because milk is the one animal food which is eaten raw in great quantities.

Bacteria which are not disease-producing cause two kinds of changes in milk, putrefaction and fermentation. *Fermentation* usually results from the action of the lactic acid bacillus and produces the normal condition of sour milk by breaking down the milk sugar into lactic acid. Milk sours because the condition or time of storage has favored the development of acid forming bacteria, its taste may be disagreeable but it is not injurious to the health. Indeed specially fermented milk has been recommended as healthful. When milk undergoes *putrefaction* the proteins are attacked by bacteria. Such milk is alkaline in reaction and bitter to the taste. It may be injurious to health.

There are always many harmless bacteria in milk but it may also contain the germs of communicable diseases. Everyone has heard of milk borne epidemics. Diseases from *animals* producing milk epidemics include tuberculosis, milk sickness, malta fever, hoof and mouth disease, contagious abortion, and various streptococcus infections. The diseases which may be transmitted from *man* in milk are tuberculosis, typhoid fever, scarlet fever, diphtheria, septic sore throat, dysentery and diarrhea. The germs of these diseases increase in number rather than die out in milk and it is extremely important that both the cows and the milk handlers should be free from such diseases.

An idea of the details which have to be considered in producing clean milk may be obtained from an examination

of the "Official Score Card," used by the United States Department of Agriculture for the purpose of rating dairy farms. (See pp. 214 and 215.)

The problems of the health department do not end here however, because the milk must be kept cool and clean from

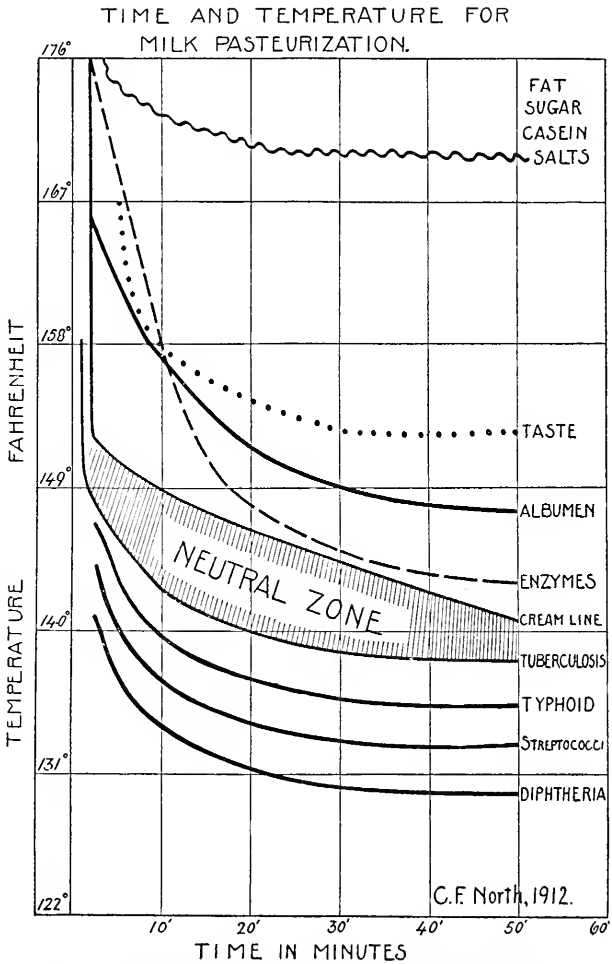


Fig. 30.—Chart showing the time and temperatures at which bacteria are killed and at which the quality of the milk is changed.

the time it leaves the farm until it reaches the consumer. Frequently milk is a long time in transit and often it is re-bottled before being finally delivered.

Pasteurization has greatly improved the milk supply of many cities as it has become more and more widely adopted. This process of heating the milk to a temperature of from 64° to 68° Centigrade for 20 minutes kills most non-spore-

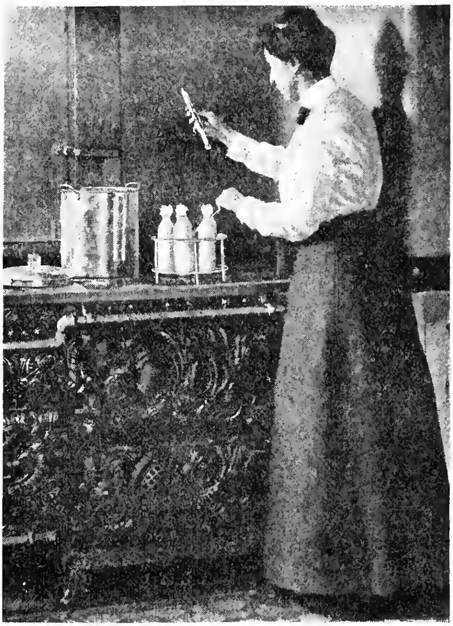


Fig. 31.—Milk may be pasteurized at home by setting the bottles in a deep dish of water or double-cooker and raising the temperature of the milk to 145° for a half hour.

bearing organisms. It is most valuable when the milk is pasteurized in the final container. If the temperatures do not go above 68° Centigrade the composition and taste of the milk are not changed.

Graded Milk.—Terms which are often used to describe various grades of milk are: Certified Milk, Inspected milk, and Market Milk.

The American Association of Medical Milk Commissions (See *Public Health Reports* No. 85, May 1, 1912) has set the standards for *Certified Milk.* Such milk is certified by a Medical Milk Commission to be produced from healthy, tuberculin-tested cattle which are subject to veterinary inspection. The milkers and the milk handlers are given physical examinations to see that they have no communicable diseases, the cattle are kept clean and are given proper food; proper sanitary precautions are taken during milking, the barn is clean, the milk is cleanly bottled at the dairy and kept cold. The bacterial count of such milk is less than 10,000 per c.c. It is delivered within 36 hours after it is produced.

Inspected Milk is of a somewhat lower grade but it comes from tested cows and it is secured and marketed under cleanly conditions. The bacterial count of such milk is less than 100,000 bacteria per c.c.

The term *Market Milk* is often used to describe milk which is below the standard of either of the above grades.

Some years ago New York City began to grade its milk supply and this practice has now been taken up by many other cities with profitable results. Grading milk has the advantage of allowing the purchaser to know the exact quality of the milk he is buying and of enabling the dairyman to get a higher price for a superior product. The table on pp. 220 and 221 from *Public Health Leaflet No. 1* of the City Health Department shows the standard set for milk of the various grades A, B, and C.

Remade Milk.—Remade milk is a new product which is being used by hospitals and other institutions with good results. This is made by mixing dehydrated skimmed milk (milk powder) and unsalted butter or milk fat with water in an homogenizer. By this process milk may be dehydrated in dairy regions far from the cities and remade in the large centers of population producing a clean, and inexpensive product. Remade milk has a low bacterial count and a good cream line. It is not easily distinguishable from fresh milk.

REGULATIONS GOVERNING THE GRADES AND DESIGNATION OF MILK

The following classifications apply to milk and cream. The regulations regarding

GRADES OF MILK OR CREAM WHICH MAY BE SOLD IN THE CITY OF NEW YORK	DEFINITION	TUBERCULIN TEST AND PHYSICAL CONDITION	BACTERIAL CONTENTS
GRADE A Milk or Cream (Raw)	Grade A milk or cream (raw) is milk or cream produced and handled in accordance with the requirements, rules and regulations of the Department of Health for that grade.	1 Only such cows shall be admitted to the herd as have not reacted to a diagnostic injection of tuberculin and are in good physical condition. 2. All cows shall be tested annually with tuberculin and all reacting animals shall be excluded from the herd	Grade A milk (Raw) shall not contain more than 30,000 bacteria per c. c. and cream more than 150,000 bacteria per c. c. when delivered to the consumer or at any time prior to such delivery
Milk or Cream (Pasteurized)	Grade A milk or cream (pasteurized) is milk or cream produced, handled and pasteurized in conformity with the requirements, rules and regulations of the Department of Health for that grade.	No tuberculin test required but cows must be healthy as disclosed by physical examination made annually.	Grade A milk (pasteurized) shall not contain more than 30,000 bacteria per c. c. and cream (pasteurized) more than 150,000 bacteria per c. c. when delivered to the consumer or at any time after pasteurization and prior to such delivery. No milk supply averaging more than 200,000 bacteria per c. c. shall be pasteurized in this city for sale under this designation. No milk supply averaging more than 100,000 bacteria per c. c. shall be pasteurized outside of this city for sale in this city under this designation.
GRADE B Milk or Cream (Pasteurized)	Grade B milk or cream (pasteurized) is milk or cream produced, handled and pasteurized in conformity with the requirements, rules and regulations of the Department of Health for that grade	No tuberculin test required but cows must be healthy as disclosed by physical examination made annually.	No milk under this grade shall contain more than 100,000 bacteria per c. c. and no cream shall contain more than 500,000 bacteria per c. c. when delivered to the consumer or at any time after pasteurization and prior to such delivery. No milk supply averaging more than 1,500,000 bacteria per c. c. shall be pasteurized in this city for sale under this designation. No milk supply averaging more than 300,000 bacteria per c. c. shall be pasteurized outside of this city for sale under this designation.
GRADE C Milk or Cream (Pasteurized) (for cooking and manufacturing purposes only).	Grade C milk or cream (pasteurized) is milk or cream produced, handled and pasteurized in accordance with the requirements, rules and regulations of the Department of Health for that grade	No tuberculin test required but cows must be healthy as disclosed by physical examination made annually	Milk or cream of this grade shall not contain an excessive number of bacteria.

NOTE.—Sour milk, buttermilk, sour cream, kumyss, matzoon, zoolac and similar and shall be pasteurized before being put through the process of souring. Sour cream shall

AND CREAM WHICH MAY BE SOLD IN THE CITY OF NEW YORK

bacterial content and time of delivery do not apply to sour cream.

DAIRY INSPECTION REQUISITES	TIME OF DELIVERY	BOTTLING	LABELING	PASTEURIZATION
Dairies are inspected at least four times a year by Department inspectors. All requisites indicated on dairy report card used by Department of Health must be complied with	Shall be delivered within 36 hours after production	Unless otherwise specified in the permit this milk or cream shall be delivered to the consumer only in bottles	Outer caps of bottles shall be white and shall contain the words Grade A, Raw, in black letters in large type, and shall state the place of production, date of shipment and the name and address of the dealer	
Dairies are inspected at least four times a year by Department inspectors. All requisites indicated on dairy report card used by Department of Health, except tuberculin testing of cattle, must be complied with	Shall be delivered within 36 hours after pasteurization.	Unless otherwise specified in the permit this milk or cream shall be delivered to the consumer only in bottles.	Outer caps of bottles shall be white and shall contain the words Grade A in black letters in large type, date and hours between which pasteurization was completed, place where pasteurization was performed, name of the person, firm or corporation offering for sale, selling or delivering same	Only such milk or cream shall be regarded as pasteurized as has been subjected to a temperature of 142-145 deg. Fahr. for not less than 30 minutes
Dairies must be inspected at least once a year by inspectors employed by operator of creamery or pasteurizing plant to which milk is delivered. These inspectors must be persons satisfactory to the New York City Department of Health, and reports submitted on approved dairy report cards must be kept on file at creamery or plant. Inspections are supervised or checked by Department inspectors at intervals.	Milk shall be delivered within 48 hours and cream within 72 hours after pasteurization.	May be delivered in cans or bottles.	Outer caps of bottles containing milk and tags affixed to cans containing milk or cream shall be white and marked "Grade B" in bright green letters in large type, date pasteurization was completed, place where pasteurization was performed, name of the person, firm or corporation offering for sale, selling or delivering same. Bottles containing cream shall be labeled with caps marked "Grade B" in bright green letters, in large type and shall give the place and date of bottling and shall give the name of person, firm or corporation offering for sale, selling or delivering same.	Only such milk or cream shall be regarded as pasteurized as has been subjected to a temperature of 142-145 deg. Fahr. for not less than 30 minutes.
Dairies not regularly inspected. Only a small quantity of milk of this grade is ever sold in the city.	Milk shall be delivered within 48 hours and cream within 72 hours after pasteurization	May be delivered in cans only	Tags affixed to cans shall be white and shall be marked in red with the words "Grade C" in large type and "for cooking" in plainly visible type, and cans shall have properly sealed metal collars, painted red on necks.	Only such milk or cream shall be regarded as pasteurized as has been subjected to a temperature of 142-145 deg. Fahr. for not less than 30 minutes.

products shall not be made from any milk of a less grade than that designated for "Grade B"
not contain a less percentage of fats than that designated for cream

Meat.—Meat is inspected by Federal, State and Local Health Agents, and in large abattoirs an inspection both before and after killing is made. One reason for making such an inspection is to see that the animal is free from such diseases as tuberculosis, anthrax, trichinosis, actinomycosis, tapeworm, septic and pyemic conditions. Later inspections of meat are to make sure that the meat has not become decomposed or infected. There is also a supervision over the processes of slaughter to see that the death of the animal is immediate and painless, that there is an immediate withdrawal of blood, that the intestines, hide and hair are promptly removed and that there is immediate cooling.

Dangers in Meat.—The important health dangers which exist where meat is not inspected are due to the following causes:

(1) *Paratyphoid Bacilli.*—If animals have had fevers, diarrhea or local suppurations and especially if the conditions of slaughter are not clean, meat may have picked up these organisms of the typhoid group, which produce diarrheas of varying intensities.

(2) *Bacillus Botulinus.*—This bacillus, which produces botulism, is an anærobic, spore-forming saprophyte, which grows outside the body and may infect meat and develop in sausages which are not kept under sanitary conditions. This organism produces an exotoxin which causes the typical symptoms of botulism when the infected food is eaten.

(3) *Trichina Spiralis.*—The small roundworm which produces trichinosis has a normal cycle in rats but the disease may extend to swine. When this happens the larvæ become encysted in the muscle of the pig producing a condition known as "measly pork." When such pork is eaten without being thoroughly cooked the larvæ develop into mature worms in the human intestines. Each female produces about 500 living young and these embryos penetrate the tissues of the bowels and find their way into the muscle of the human subject producing pain, fever, soreness and other symptoms of the disease.

Microscopic examination of meat is fairly successful in detecting the presence of these parasites. All pork should be cooked until it is thoroughly white and hams should be boiled for ½ hour for every kilogram weight to kill the organisms.

(4) *Tænia Solium.*—The encysted larvæ (bladder worms) of the pork tapeworms may be eaten in pork. This infection is particularly dangerous because the larvæ develop in man and may find their way to important parts of the body such as the eye, or the brain.

(5) *Tænia Saginata.*—This tapeworm occurs only in cattle and in man. The larvæ are found embedded in beef and when such meat is eaten they develop in the human intestines. This tapeworm is not dangerous although it causes anemia and is often difficult to expel. Man is infected from uncooked beef while cattle are infected by eggs passed in human feces.

(6) *Tænia Echinococcus.*—This minute tapeworm of the dog frequently infests cattle, swine, horses and sheep, reaching the digestive tract of the new host in the form of the eggs which are passed in the feces of the dog. The embryoes develop in the digestive tube, pierce the mucosa and become encysted in various tissues and organs of the body. Man like the other animals mentioned is infected from the dog by ingesting eggs which are passed in the feces.

(7) *Ptomaine Poisoning.*—Much less is heard recently of ptomaine poisoning which has been regarded as being produced by a poisonous substance formed in the decomposition of proteins. Many cases of supposed ptomaine poisoning have been found to be infections or intoxications produced by such organisms as paratyphoid or botulinus.

Prepared Food.—The sanitation of prepared food is secured through the supervision of restaurants, food stores, and other places where food is sold. The score card shown on page 224 for food stores used by the Health Department of the City of Boston shows the factors of cleanliness which are considered.

FOOD ESTABLISHMENTS
SCORE CARD

LOCATION ....

DISTRICT .... ROUTE NO. ....

KIND OF STORE ....

NAME OF PROPRIETOR.. DATE ....

EQUIPMENT	Perfect	Allowed
Construction:		
Floors	3	....
Walls	2	....
Ceilings	1	....
Arrangement:		
Proper rooms	4	....
Conveniences	3	....
Light	5	....
Ventilation	5	....
Screens	5	....
Cellar	3	....
Plumbing:		
Sufficiency, Kind, Quality, Location, Condition — Water-closets ...	10	....
Sufficiency, Kind, Quality, Location, Condition — Sinks	10	....
Ice boxes	10	....
Drainage	4	....
Counters and show cases	5	....
Utensils	5	....
Hot water facilities	15	....
Cold water facilities	10	....
Total	100	....

METHODS	Perfect	Allowed
Cleanliness:		
Floors	5	....
Walls	2	....
Ceilings	2	....
Doors	1	....
Windows	1	....
Ice Boxes	10	....
Counters and show cases....	5	....
Sinks	5	....
Utensils	10	....
Employees	5	....
Good order	1	....
Free from odors	2	....
Free from flies and other insects	6	....
Food articles		
Condition	15	....
Storage	10	....
Handling	5	....
Cleanliness	5	....
Waste Receptacles:		
Adequate	5	....
Condition	5	....
Total	100	....

Score for equipment......multiplied by one equals ......

Score for methods......multiplied by two equals......

Total to be divided by three to obtain final score......

Milk record

Milkman ....

Number quarts sold daily......

Ample ice ....

Is milk on ice? ....

Are milk utensils thoroughly clean? ....

REMARKS

(Under this heading denote unusual conditions as sleeping accommodations, the presence of domestic animals in or about shop or rooms, noncompliance with regulations and infractions of statute laws.)

....

....

....

Inspector.

CITY OF BOSTON—HEALTH DEPARTMENT

Two factors not mentioned in such a score card but of extreme importance in food sanitation at restaurants and hotels are the physical examination of food handlers and the method of dish washing. A waiter or food handler who is tuberculous or who is a typhoid carrier may infect food prepared in the most cleanly kitchen. The case of one such carrier, "Typhoid Mary," has become famous. No person harboring the germs of typhoid or any other infectious disease should be allowed to handle food. The startling discoveries of Dr. Cumming, showing how dishes which are not scalded may convey respiratory diseases, are described in the discussion of influenza. Both in the home and in public eating places the germs of tuberculosis, common colds, influenza, septic sore throat and other diseases are doubtless carried from diseased persons to healthy individuals on unscalded dishes much more often than we have previously realized.

CHAPTER XII

WATER SUPPLY

The danger of transmitting disease by polluted water has been well recognized since the epidemic of the Broad Street Well in 1854. We know now, as they did not then, that the danger is not from a particular and peculiar poisonous substance, but rather from the germs of infectious disease which remain alive in the water and reproduce the disease by multiplying in the digestive tract of the individual who has drunk thereof. Water-borne epidemics of typhoid fever, cholera, and diarrhea have been so numerous and so important that the people at large now have a very keen appreciation of the danger from a polluted water supply.

Although freedom from disease germs is a most important characteristic of good water, there are many other important considerations in securing a city water supply. Indeed if disease germs were the only menace, that danger could be avoided by always boiling water before drinking it. Such a precaution is used by travelers and explorers where the source of water is unknown. In China, where the population is dense, most of the wells are polluted and the people are saved from intestinal disease by their tea-drinking habit, through which they avoid the use of raw or unboiled water.

Important as water is for the body there are many ways in which it is used outside the diet and it is because so much is needed that it is difficult to secure a satisfactory supply. The average American city uses 100 gallons of water a day for every inhabitant. Water has the property of picking up dirt so readily and the outlying districts of cities become settled so soon that the water shed or drainage basin from which water would naturally be secured contains many habitations

and the opportunities for pollution with human or animal waste are innumerable.

What Is Good Water?—The characteristics of a good water supply may be enumerated as follows:

1. *It should be free from the germs of infectious disease.*

2. *It should be free from poisonous metals, particularly lead.* It is well known that lead is a cumulative poison which is readily taken up by the body in small quantities and which has serious effects particularly upon the stomach and the nervous system. "Painter's colic" and "wrist-drop" are typical symptoms of this type of poisoning. Some waters have a much greater solvent action upon lead pipe than others.

3. *The water should be of suitable temperature,* certainly less than 80°F. If the water is too warm it will not be used as much as it should be for drinking purposes.

4. *The water should be low in color,* otherwise it will not be acceptable. Color may be harmless but a highly colored water will not be generously used.

5. *It should be clear,* i.e., free from suspended matter, like sand or clay.

6. *It should be odorless.* The odor of water most frequently comes from small or microscopic plants which grow in the lake or reservoir and which of themselves are entirely harmless. The odors which they produce, however, are distinctly disagreeable and may make the water offensive.

7. *The water should not be too hard,* since hard water makes laundering particularly difficult. This is caused by the reaction of the calcium or magnesium salts of hard water in displacing the sodium of soap. Such a reaction forms a precipitate of the above mentioned salts and enough soap must be added to use up all the calcium and magnesium in the water before any lather is produced. Hard water is therefore unpleasant to use on the flesh and costly for laundering purposes.

8. *It should be practically free from iron.* Otherwise clothes will be stained or "rusted" in the laundering process.

Sources of Water Supply.—There are two kinds of water supplies, surface waters and ground waters. We can better appreciate their differences if we follow the history of water after it falls as rain. It may fall directly into rivers or lakes, or it may reach them by running over the surface of the ground. More often it reaches them by soaking through the soil just beneath the surface, for ground water is always in motion, moving from 0.2′ to 20′ per day, toward visible or underground rivers or in the direction of their flow. Water taken directly from rivers and lakes or temporarily stored in reservoirs constitutes a surface water supply.

Surface Water, which has washed over the ground and which in rivers and lakes furnishes the home for innumerable plants and animals, naturally contains many things besides hydrogen and oxygen; in fact chemically pure water is difficult to secure even in the laboratory. In nature water which appears perfectly clear to the eye may reveal many things upon chemical and microscopic examination. It contains dissolved oxygen, upon which the fish and other animals live, nitrates and other salts used by plants, carbon dioxide and perhaps ammonia, marsh gas and other chemical substances. An examination with the microscope reveals particles of dirt, bacteria, minute plants and animals, bits of wood and fibers of one sort or another. If this water has passed over polluted ground, filth and disease germs may be added to its contents.

Ground Water is obtained from wells of various depths and may be free from many of these substances, which are caught and held back as the water strains through the soil. Sandy or gravelly soil is the best filter for water, and in passing through 100 feet of sandy soil water will be purified for a considerable period. Finally, however, even this soil would become polluted and a well 100 feet from a privy or other source of pollution would be endangered. When in place of sand we have a broken formation, as is the case with limestone or some types of ledge, there may be a break having a rivulet by which pollution may reach the well directly.

The difference between surface wells and deep wells is one of character and not primarily one of depth. A *surface well* is one which does not reach through the first impenetrable layer of soil; while a *deep well* does go through the impervious layer and furnishes its water from the water table. A deep well may be a quiet well from which the water is pumped, or it may be an artesian well from which the water flows freely. The artesian well is produced by a water pressure beneath

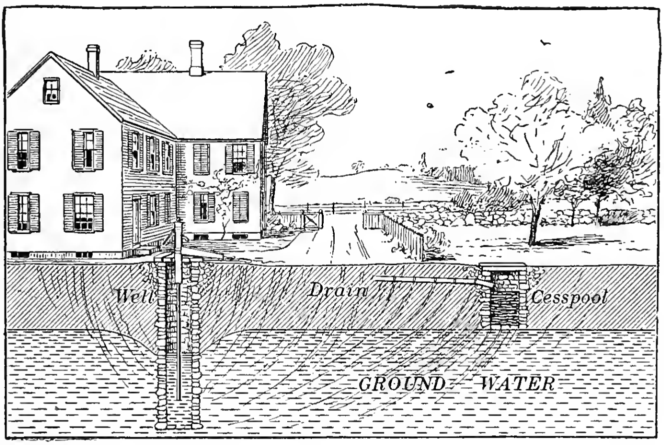


Fig. 32.—Wells may be polluted by water which soaks through the soil from privies or cesspools. The danger of pollution is less in sand and gravel soil but these may finally become saturated and permit infection. (The Human Mechanism.)

the impervious layer of soil which is sufficient to throw water to the surface.

Well water has been used for generations. It is usually clear, cold and sparkling and most people believe that well waters are almost always safe. The contrary, however, is frequently the case, especially where wells are dug in unsewered villages where the soil is heavily polluted. In fact a clear and sparkling water *may* be more dangerous than the yellow and smelly water of a stagnant pond for, as we shall see later, water purifies itself by storage. The water from

deep wells is usually more reliable than that from shallow wells because it has been in the ground longer and has worked its way through the soil for a long distance. Any student of bacteriology knows that a glass of water may contain thousands of typhoid bacilli without showing the slightest trace of sediment. When people generally realize this they will cease to judge the quality of drinking water by its appearance.

WATER ANALYSIS

A careful examination is necessary to really determine the quality of a water supply. Such an examination includes four factors. A study of (1) the environment, (2) a bacteriological examination, (3) a microscopic examination, and (4) a chemieal examination.

1. **Environment.**—In order to estimate the value of water the sanitarian must know the nature of the water shed from which it comes; that is, the number of inhabitants in the drainage area, and the nature of the soil and slope of the drainage basin. A laboratory examination of the water at some particular time might be satisfactory and yet if the water came from a populous district with a clay soil and steep slopes, a heavy rain might wash great quantities of pollution into the stream or lake.

2. **Bacteriological Study.**—The second step is the bacteriological examination of a properly secured sample of the water. By plating out the water in different dilutions the total number of bacteria may be determined and by using different temperatures for incubating the petri dish plates the number of water bacteria can be contrasted with the number that grow well at body temperature.

Tests* are also made to determine the number of bacillus

*Laboratory directions for making a complete water analysis may be found in "*Standard Methods of Water Analysis*" published by the American Public Health Association. Such directions would be out of place in a discussion for dental practitioners. However, it does seem advisable to describe the principles involved in the interpretation of a water analysis.

coli in the water. It is not easy to detect typhoid bacilli or other disease germs when they are present but the colon bacillus, which is a normal inhabitant of the intestines, is easy to discover and determination of its presence gives a good indication of the pollution or purity of the water in question. Of the various bacteriological tests which are made these two, the total bacteria and the presumptive test for B. coli, are the most important.

3. **Physical Tests.**—The physical tests which are made upon water include an examination for odor, temperature, color and turbidity.

The *color* is expressed in parts per million and is determined by comparing the water with a platinum-cobalt standard. True color is produced by substances in solution, many of which come from vegetable tissues soaking in the water.

The *turbidity* is likewise expressed in parts per million and is usually determined by comparing the water with a standard suspension of silica. It is produced by finely divided suspended matter like clay, silt and microscopic organisms.

The *odors* are described as fishy, vegetable, aromatic, grassy, earthy, mouldy, musty, disagreeable, peaty or sweetish. They are caused by decomposing organisms, fermenting material, or gases like hydrogen-sulphide or methane. Many of the tiny green plants, particularly the diatoms have quite distinctive odors.

It will be seen from the above that the physical examination of water tells much about its condition but little about its sanitary quality.

4. **Chemical Tests.**—The most important chemical tests from the sanitary point of view are the tests for nitrogen in its various forms and the test for chlorine. The nitrogen tests give us an index of the quantity, the nature and the freshness of pollution by nitrogenous waste material. The test for chlorine is a valuable indicator of pollution because in soils free from salt deposits the only source of chlorine, except for salt mists brought in from the ocean, is the waste of the body.

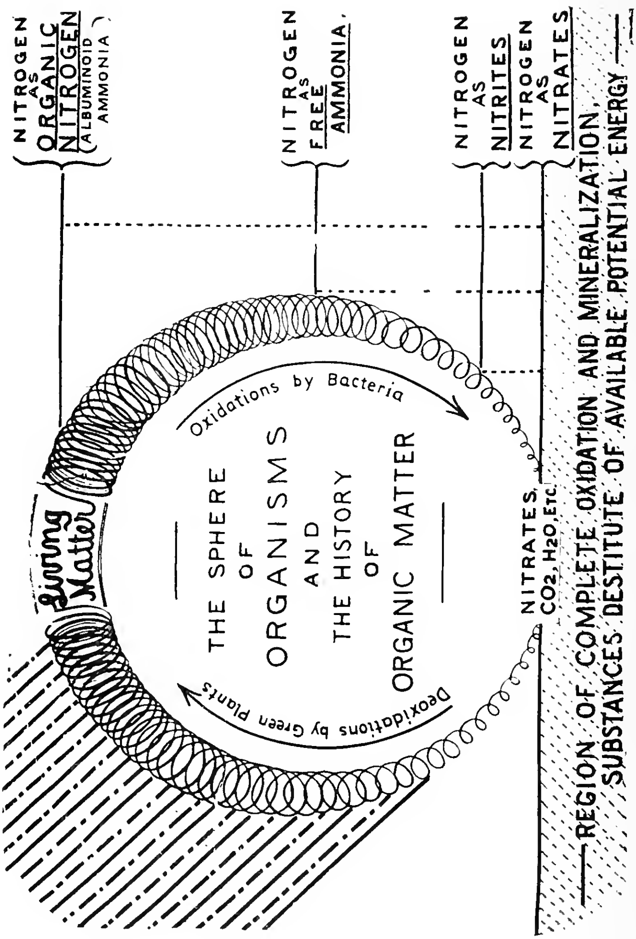


Fig. 33.—The nitrogen cycle.

Nitrogen and the Nitrogen Cycle.—To understand the meaning of the nitrogen tests we must recall for a moment the story of the nitrogen cycle. We find this important element going through an endless chain of changes. Inorganic nitrogen is taken up by plants in its simple inorganic condition and transformed into plant protein from which in turn it is transformed into animal protein by herbivorous animals. When these complex proteins from living animals are left exposed in the air or in water they return to their simple condition by a series of definite oxidation processes. In this series of changes the nitrogen is found consecutively in complex proteins, albuminoid substances, ammonium salts, nitrites and nitrates. Special microorganisms carry out the last two steps. Ammonium compounds are acted upon by nitrosomonas and oxidized to nitrites. Nitrites are oxidized by nitrobacter to nitrates. In making a chemical analysis of water we can determine the amount of nitrogen in these various conditions.

The test for *nitrites* is particularly valuable because the test itself is very delicate and because nitrogen passes through the nitrite stage very quickly. The analysis will readily determine the presence of 0.01 parts of nitrites per million. Even this small quantity shows clearly that organic substances are being broken up in the water. This is an indication of fresh pollution for if the pollution were remote the nitrogen would be found in some of its more stable compounds.

The test for *free ammonia* determines the amount of nitrogen present in the water as ammonium salts, which are readily driven off on the direct distillation of slightly alkaline water. A large amount of free ammonia also indicates pollution, although it may be remote.

The test for *Albuminoid ammonia* measures the amount of ammonia set free from nitrogenous organic matter by the action of boiling alkaline potassium permanganate. This is therefore a good index of the amount of easily decomposable organic matter in the water. It may come from plant sub-

stances or from animal wastes but when it is from a vegetable source the water is usually colored and the nitrogenous material is more stable. It therefore follows that a colorless water should contain less albuminoid ammonia than the yellow waters of natural storage reservoirs.

Nitrogen in the form of *nitrates* is the final product of the process of oxidation or mineralization. These are the stable compounds which are used as food by plants in building up the nitrogen to the organic form. If the nitrates are high it indicates that a good deal of nitrogen has gone through the mineralizing process and therefore a high figure may indicate pollution even though it be remote. Good ground water may contain more nitrates than surface water because the nitrates of ground water are not used up by growing plants.

By a continued study of water supplies of various sorts a set of *standards* or limits can be set as to the amount of these various substances a good water may contain, although in every case, the final interpretation of the chemical analysis should be made by an expert. In general a safe water should not contain more of these substances than is indicated in the following table.

NITROGEN LIMITS IN A SAFE WATER SUPPLY EXPRESSED IN PARTS PER MILLION

Nitrogen as albuminoid ammonia 0.15 (colorless water) 0.4 (colored water).
Nitrogen as free ammonia 0.15.
Nitrogen as nitrites 0.01.
Nitrogen as nitrates. 1. (surface water) 2. (ground water).

Chlorine.—Chlorides occur mostly as the sodium salt and the results are usually expressed in terms of chlorine. As stated above waters coming from soils free from salt deposits receive chlorine from only two sources, salt mists blown in from the ocean and animal wastes, principally urine. (Human urine contains about one per cent sodium chloride.) It therefore follows that unpolluted waters near the ocean would con-

tain more chlorine than those at some distance from the coast. By the analysis of a large number of samples from waters of known purity in various parts of a coast state the normal amount of chlorine for each particular district can be determined and if a suspected water contains more than the "normal" amount of chlorine it may be justly concluded that an additional amount has been derived from pollution. It will be seen that it is not the number of parts per million of chlorine but the relation of the amount of chlorine to the "normal" which is taken into consideration in interpreting this chemical test.

5. *Microscopic Analysis.*—We have seen that disagreeable tastes and odors commonly arise from the presence of microscopic plants and animals in water. Their presence can be detected by straining some of the water through sand and then washing the microscopic organisms from the sand and examining the wash water under the microscope. In investigating a prospective water supply it is desirable to know whether it contains these troublesome organisms and in testing the water of an old supply it is important to learn of any increase in numbers or of the sudden appearance of any organism; because by treating the water with copper sulphate the objectionable plants may be killed and the disagreeable tastes and odors prevented.

This examination follows the so-called Sedgwick-Rafter process in which 500 c.c. of the water is filtered through sand from which the organisms are washed with 5 c.c of wash water. This concentrated sample is examined on a special slide in which the water is just one millimeter deep. A special micrometer is used in the microscope to mark off a field one millimeter square so that in looking through the microscope the number of organisms in a cubic millimeter of the concentrated sample may be determined. By counting a number of fields a fair average may be obtained and the number of organisms in the original sample may be computed. This test is regularly made in city water laboratories because

the number of objectionable organisms varies at each season of the year and it is important to determine their increase before a nuisance is produced.

By the above tests the sanitary and aesthetic quality of a drinking water supply may be accurately determined and by the addition of special tests for hardness, iron, etc., its fitness for industrial purposes may be estimated. It is hardly necessary to repeat that the quality of a drinking water cannot be determined by its appearance to the naked eye.

WATER PURIFICATION

It frequently happens that safe water supplies are not available and some method of purifying the water must be adopted. There are three important methods in general use: (1) Storage, (2) Filtration, and (3) Chlorination.

Storage.—Storage is the natural way of purifying water and it is utilized by man in securing water from lakes and reservoirs. Bacteria and other particles settle to the bottom of standing water and what is often most important the bacteria themselves die of old age or are devoured by other organisms.

It was the privilege of the author to study this process of natural purification in a small stream which received the partially purified sewage effluent from the city of Brockton, Massachusetts. (Reported as "*Studies on the Purification of a Sewage Filter Effluent by a Small and Otherwise Unpolluted Stream,*" by Weston and Turner in Contributions from the Sanitary Research Laboratory and Sewage Experiment Station, Volume X, M. I. T., Cambridge, Mass., 1917.) This study showed that the process of self-purification is largely biological and that still water purifies itself much more rapidly than running water, because in the latter case the plants and animals which assist in purification processes are swept away while in still water they accumulate in enormous numbers.

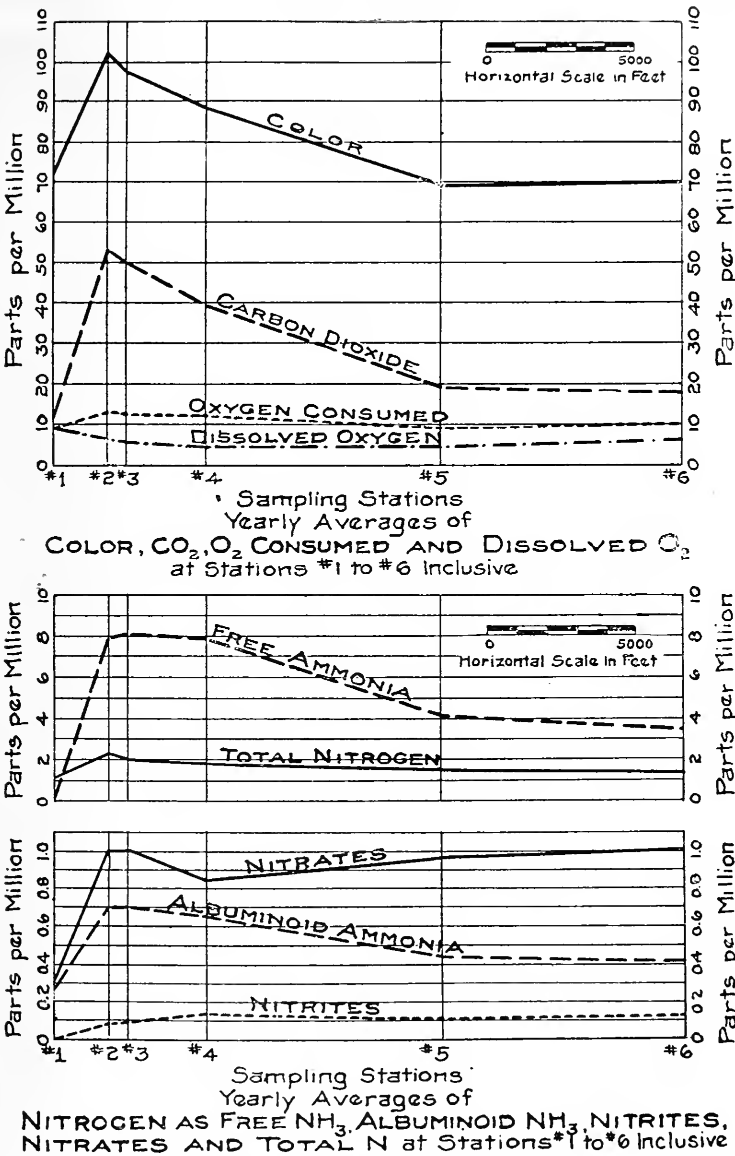


Fig. 34.—Diagram showing the condition of the stream studied at Brockton. The chart shows the average figures obtained from weekly analyses of the water at each sampling station covering a full year.

At the point where the pollution enters the stream there is a sudden increase in the number of bacteria. These break down the organic substances of pollution but they themselves are used as food by protozoa which are found in great numbers just below the place where the bacteria are most numerous. The protozoa in turn are devoured by small crustacea and other higher animals, which are suitable food for fish. The abundance of the carbon dioxide and nitrates is removed

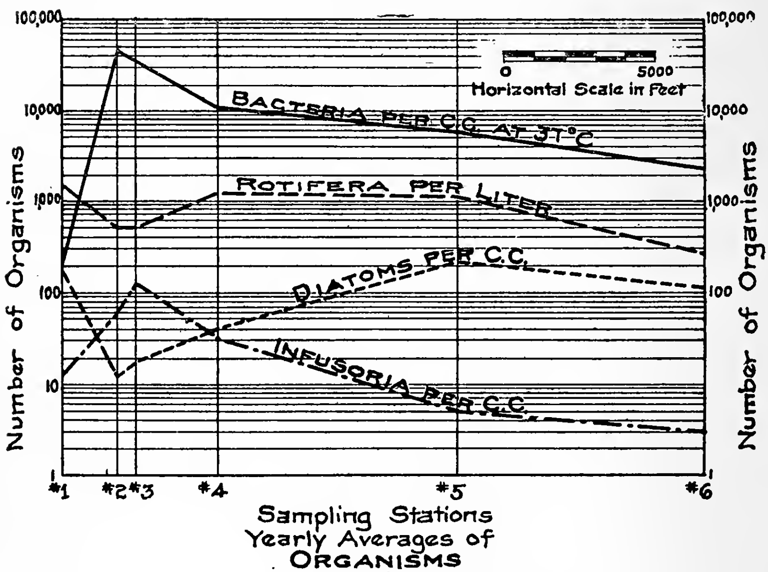


Fig. 35.—Diagram showing the abundance of microorganisms at the various sampling stations.

by simple and higher plants which grow in such a quantity as to almost clog the stream and furnish protective habitations for the millions of tiny animals which nature is using in the purification process.

The accompanying diagram shows the effect upon the stream produced by introducing the sewage effluent, which came in between sampling stations No. 1 and No. 2. The other sampling stations indicated in the diagram are approximately

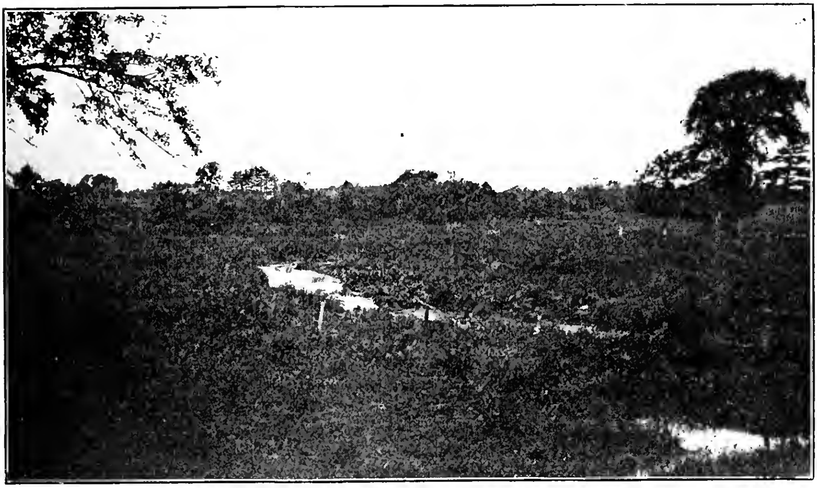


Fig. 36.—This view of the stream taken near Sampling Station No. 4, on July 21, 1915, shows how completely the higher acquatic plants fill this part of the stream in summer. These plants strain out the suspended matter and prevent the smaller plants and animals from being carried down-stream.

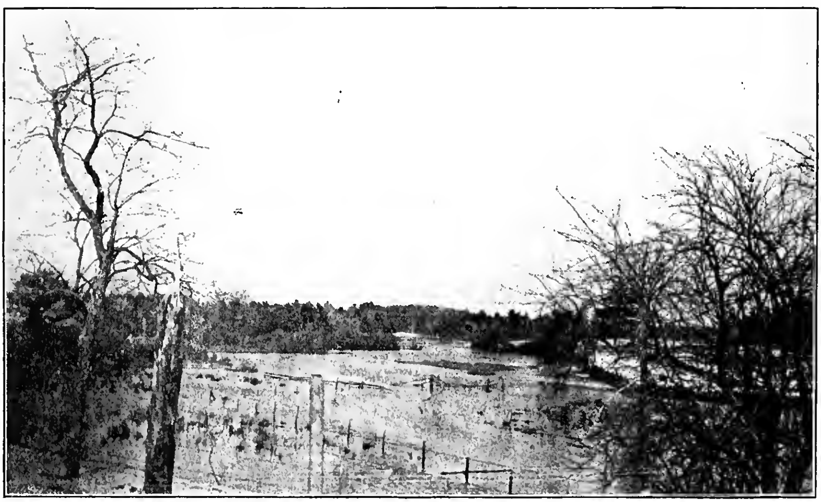


Fig. 37.—A corresponding view January 26, 1916, showing how differently the same region appears under winter conditions and high-stream flow. The biological processes of purification are greatly reduced. There is greater dilution but less purification.

the following distances below station No. 2: No. (3), 980 feet, No. (3a), 2000 feet, No. (4), 3650 feet, No. (5), 11,580 feet, No. (6), 19,700 feet.

The storage of water is a simple method of purification and is inexpensive except where there may be a high cost for reservoir construction. Experiments indicate that all the disease germs usually die out in water which has been stored for a month. In reservoirs and in relatively pure waters the biological activities are not as intense as in heavily polluted water and most of the bacteria are settled out on the bottom or they die of old age or lack of food.

Filtration.—There are two types of filtration for drinking water, slow sand filtration and rapid sand filtration. In the construction of a *slow sand filter* a concrete floor is first laid down and drains with open joints are laid along this impervious bottom, the joints being covered with small rocks. Then the whole filter bottom is covered with gravel to a depth of several inches and on top of the gravel there is a layer of sand about 3 feet in depth. In cold climates the whole structure is placed low in the ground and roofed over with a concrete roof which is covered with soil. This is necessary to prevent the surface from freezing up during the winter months.

Such a filter, as the one at Washington, D. C., is made up of large units of about one acre each in area. The water is run onto the sand to a depth of 3 or 4 feet and filters rapidly. One acre of filter surface is capable of filtering about three million gallons of water per day. This process will remove 99 per cent of the bacteria and suspended particles and will reduce the color 30 per cent. A description of the biological principles of the slow sand filtration will be found in the chapter on Waste Disposal.

The *rapid sand filter* or "mechanical filter" or "American Filter" as it is sometimes called, is designed to accomplish the purification process with much less sand area. In this process a coagulant is first added to the water to produce a

chemical precipitate. The substances commonly used are lime and alum which react to produce aluminum hydroxide. These chemicals are thoroughly mixed with the water which is then passed through a storage tank where the precipitate settles out carrying down with it many of the bacteria and much of the dirt suspended in the water.

From the top of this tank the water is drawn off to the filter, which in principle of construction, is similar to the slow sand filter except that it is much smaller in area and is enclosed in a sort of concrete bin. This filter is also supplied with devices which make it possible to wash the surface of the sand by forcing water back up through the filter. This washing process must be carried out frequently as the coagulant collects on the top of the sand and clogs the filter. The bacterial efficiency is about 98 per cent or 99 per cent and it operates at the rate of 125 million gallons of water per acre per day.

Chlorination is the third important method of purifying water. Chlorine is added either in the form of chloride of lime or as chlorine gas liberated from tubes of liquid chlorine. Various chlorinating devices are on the market. In whatever form the chlorine is used enough must be added to kill the nonspore-bearing bacteria and care must be taken to avoid adding so much as to give a disagreeable taste to the water.

Sometimes complaints are heard because of chlorine tastes in water but the careful operation of chlorine plants should make it possible to avoid serious difficulty in this matter. Not long ago I had occasion to investigate the water supply of a small town. The water was taken directly from the river and although chlorination had been going on for nearly a year I was informed by the Chairman of the Local Board of Health and other citizens that nothing whatever was being done to purify the water. Apparently there were no disagreeable tastes in this instance. At about the same time a quite different incident came to my attention at another town. It was generally known that chlorine was about to be used in the

water although the exact time when treatment would begin was not known. Complaints of its disagreeable taste reached the Health Officer two days before any chlorine whatever was used.

When the taste of chlorine does occur it is disagreeable but sometimes at least complaints are more imaginary than real. The amount of chlorine necessary to disinfect a water depends upon the amount of organic matter present. Proper methods of chlorination render the water practically free from non-spore-bearing bacteria.

CHAPTER XIII

WASTE DISPOSAL

Sanitary engineering is a science by itself. But there are certain facts and important principles involved in waste disposal which any person might well know. We shall first describe some of the principles involved in the purification of sewage and the disposal of wastes, and then discuss some of the problems in waste disposal for a rural community or for a residence, because it often happens that those who are not sanitary engineers like to know about the methods applicable at a camp, a cottage or an institution in which they may be interested. By waste disposal we mean the disposal of sewage and garbage.

SEWAGE DISPOSAL

Sewage is the material discharged into the sewers of a city or community and should not be confused with the word sewerage which has to do with the sewer pipes themselves. Sewage is the material and sewerage the piping system which carries the sewage.

Our consideration will be directed mainly to domestic or household sewage, which consists chiefly of excreta mixed with the sink wastes, and other waste waters going from the house. In city sewage there are also street washings and manufacturing wastes.

It is unnecessary to dwell upon the importance of proper sewage disposal. In a previous chapter we have seen that lack of care in disposing of sewage from houses where there are cases of intestinal disease may result in serious epidemics. The organisms of such intestinal diseases as typhoid, cholera, dysentery, and paratyphoid are discharged in innumerable

quantity in the feces of the patient and may remain alive for many days, for weeks even. And wherever drinking water, milk or food becomes contaminated with the excreta from these patients there is a possibility of spreading the disease. So that the first and most important problem in sewage disposal is to take such care of excreta that there will be no opportunity for spreading infection. But we must not only take care of sewage in such a way that germs will be killed but also in such a way that it will not produce a nuisance in the community. The problem of proper waste disposal is not a simple one.

In considering disposal we need to know the composition of sewage. The most important constituent of domestic sewage is the protein and other organic material of the excreta. Human excrement is composed largely of bacteria together with undigestible products like cellulose and the secretions of the mucous lining of the digestive tract, the bile salts and special substances like inorganic compounds. Most of this material is protein and carbohydrate, with a small amount of fat.

Direct Disposal.—Sewage may be disposed of either directly or by purification. In cities located on the seashore or on great rivers and lakes disposal by dilution or the direct discharge of sewage into a large body of water is possible. A stream can purify about one-fiftieth of its own volume of raw sewage. In the woods or on farms excreta may be covered with soil. But in the interior of the country where the population is becoming more dense and where all the streams are used as drinking water supplies some other method of purification must be resorted to.

Chemical Purification.—Artificial methods of sewage disposal are by either chemical or bacteriological purification. By chemical purification we mean adding some chemical like a strong alkali or acid or chlorinated lime to the sewage in order to disinfect it. We shall cite but three examples of

purification by chemical processes; the chemical closet, chemical precipitation and the Miles process.

The Chemical Closet in its simplest form may be used inside the house. It consists of a jar placed in a closed box under a toilet seat and containing a strong solution of caustic soda which disinfects and partly dissolves the excreta which reach the liquid. These closets are nearly free from odor. They are made by dozens of manufacturers in America and

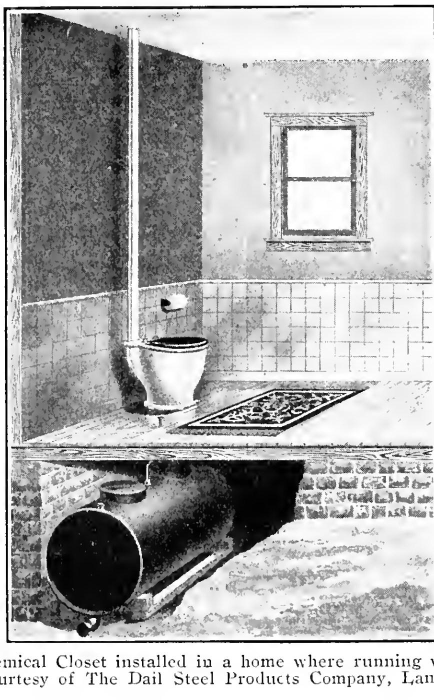


Fig. 38.—A Chemical Closet installed in a home where running water is not available. (Courtesy of The Dail Steel Products Company, Lansing, Mich.)

may be obtained either as a single unit consisting of a single seat or as a large unit consisting of several seats over the tank. Such installations are now used in many boys' camps and in hunting camps.

Chemical Precipitation of the solids in sewage is sometimes secured by the addition of chemicals, like lime and alum,

which form a flaky precipitate, carrying down with it the light floating particles in the sewage. This precipitation takes place in a large chamber or settling basin, the water is drawn off from the top and the remaining solids (sludge) are usually pressed to expel as much water as possible. The dried sludge is hauled out to sea or buried on waste land. It has small fertilizer value and is therefore not salable, although at some purification works a portion of the sludge is hauled away by farmers for fertilizer purposes.

This process is not much in use at present because chemicals are expensive and because the degree of purification secured is not high. The liquid effluent from this process is putrefactive and needs further treatment unless there is opportunity for great dilution, the sludge is produced in large quantity and there is no easy method of securing its final disposal.

The so-called *Miles Process* has recently been suggested for the treatment of sewage in very large cities. This process disinfects the sewage with sulphurous acid, by introducing SO_2 into a large tank of sewage and allowing the clear and nearly sterile liquid effluent to flow on into the river or the ocean at the same time collecting the solid material and fats in sedimentation chambers. The proteins settle out at the bottom of the tank and may be used as fertilizer base. The fats are released by the chemicals and may be skimmed from the top of the liquid, purified and sold for soap grease. This process is still in the experimental stage but seems to be worthy of trial by large cities.

Bacteriological Purification.—There are two widely different processes for the bacteriological purification of sewage, the ærobic and the anærobic. It is the presence or absence of oxygen that determines which of these two processes will take place.

Ærobic Processes.—The biological principles of ærobic purification have already been alluded to in our reference to the nitrogen cycle in the discussion of the interpretations of the chemical water analysis. When enough oxygen is sup-

plied to sewage, as it is being broken down by the bacteria contained within it, much of the nitrogen is finally converted into nitrates through the various descending steps of the nitrogen cycle. Carbon dioxide is also produced in large quantities. When the process is completed the solid residue of the sewage (sludge) has somewhat the consistency of humus soil. Practical applications of this principle are found in Sewage Farming, Intermittent Sand Filtration, Rock Filters and Æration.

1. Sewage Farming.—It has long been known that it is possible to purify sewage by allowing it to flow on to soil which is largely sand or gravel. This is merely the utilization of the agricultural process of fertilizing land. Near Paris many acres of sewage farms have been in operation since 1866. Farmers buy sewage from the city securing thereby both water and fertilizer. Gates and ditches are built in such a way that the flow of sewage may be directed to the desired section of the farm. There are smaller sewage farms in Europe much older than those in Paris.

The purification of sewage by this method is almost complete for the solids are left upon the surface and the water, which soaks through the soil and finally makes its way to the streams, lakes or rivers, shows little trace of pollution. But in order that sewage farming shall be a success the soil must be mainly sand or gravel and free from clay, peat and chalk. Moreover a great deal of land is required since in American cities about an acre of land is necessary to treat the sewage of 100 people. The rate of filtration on the sewage farms near Paris is 12,000 gallons per acre per day. There are a few sewage farms in California where soil and climate are favorable, but for the most part American cities use more intensive methods of sewage disposal.

2. Intermittent Sand Filtration.—Although earlier and limited laboratory studies had been made in England, the principle of the purification of sewage by filtration through sand was largely developed at the Massachusetts Sewage Ex-

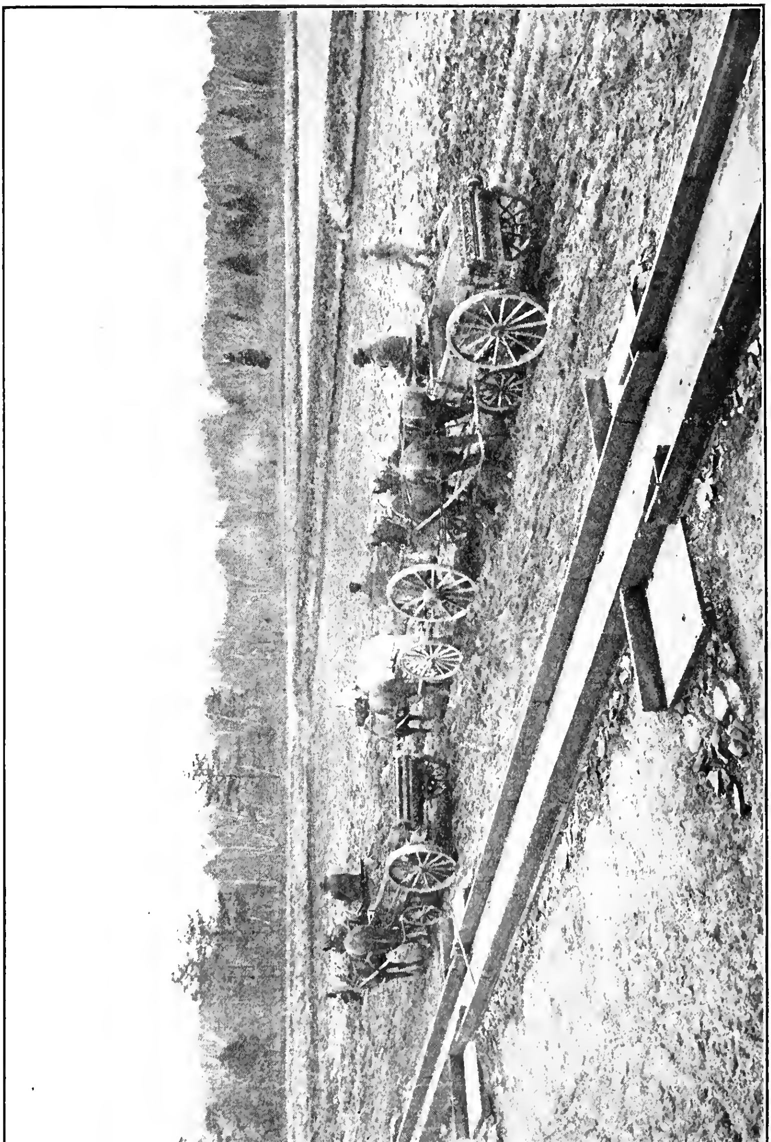


Fig. 39.—Removing the sludge from the sand beds at the Brockton Sewage Purification Works.

periment Station, at Lawrence, between 1886 and 1890. In these experiments sewage was filtered through several feet of sand which had been placed in large round wooden tanks. These experiments, which first combined biological, chemical and engineering research in behalf of the State and in the interest of the public health, form an important and interesting chapter in the history of sanitary progress.

Sand beds as they are now constructed are usually about one acre in area and from 4 to 5 feet deep. In making such a bed underdrains of tile with open joints are first laid. The joints are protected with rocks and gravel to prevent the drain from becoming clogged. Then coarse sand is placed over the drain to a depth of 2 or 3 feet and fine sand is used for making the top of the filter. The bed is flooded with sewage to a depth of a few inches and then allowed to dry after which a "breathing space" of several hours is allowed before a second dose of sewage is put on the bed.

The reason for this intermittent method of dosing the sand bed becomes apparent upon a consideration of the biological principles involved. It is found that as the bed is used the sand grains near the surface become coated with a gelatinous growth of the oxidizing bacteria to which the sewage purification is due. This gelatinous coating of the sand grains makes the filter more tight and as the coating becomes heavier with increased numbers of bacteria the efficiency of the filter rapidly increases. These are ærobic or oxygen breathing bacteria and it is therefore necessary to let the filter rest or "breathe" long enough for oxygen to penetrate into the bed between the times when the bed is flooded with sewage.

A good intermittent sand filter will remove 99 per cent of the bacteria of sewage and effect a very high degree of purification. In fact the effluent from such a filter is almost a "drinking water" effluent. A filter bed one acre in area will treat from fifty thousand to one hundred thousand gallons of sewage per day. In other words one acre of filter will provide sewage treatment facilities for about six hundred people.

3. Sprinkling Filters.—Sprinkling or percolating filters treat sewage much more rapidly than intermittent sand filters. They make use of the same biological principle of ærobic bacterial action but the purification which such filters effect is not as complete as in the case of the sand filter. They are from 6 to 8 feet deep and are composed of broken stone, coal or coke with an effective size of from 1 to 3 inches. This broken stone is placed upon a concrete floor which is properly drained. The sewage is thrown onto the bed through sprinkler nozzles which spray the sewage into the air in much the same way that water is thrown into the air by a lawn sprayer. This allows the sewage to accumulate oxygen from the air and it is also continuously in contact with the air as it trickles over the rocks of the porous filter.

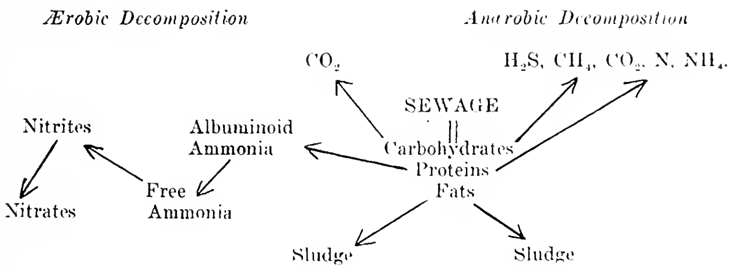
Filters of this type properly constructed and operated may be depended upon to remove from 70 per cent to 90 per cent of the bacteria and to produce a non-putrescible liquid effluent. This effluent however contains suspended solids which are easily settled out and which are putrescible. The average rate of filtration in American filters of this type is about two million gallons per acre per day.

4. Activated Sludge.—A more recent development in the treatment of sewage by the ærobic process involves bubbling air through the sewage as it passes through a deep tank. A few inches above the real bottom of such a tank there is a false bottom, which contains many square plates of porous tile. Air is forced through these plates in fine bubbles which make their way through the sewage to the top of the tank. By continually forcing air through the sewage the small particles of sludge soon become "activated" by the accumulation of mineralizing bacteria so that the rate of nitrate formation becomes exceedingly rapid.

A bacterial removal from 80 per cent to 90 per cent is claimed for the process, a liquid effluent of high quality is obtained and the sludge is nonputrescible and of good fertilizer value.

Anærobic Processes.—The anærobic decomposition of sewage which takes place whenever sewage is stored in large tanks is quite a different process. Under these conditions the available oxygen is soon used up by the ærobic or free-oxygen breathing bacteria. Such bacteria soon die for want of oxygen and there remains only the anærobic bacteria: those which are able to wrest their oxygen from the organic compounds undergoing septic action. From such a process three gases are produced from the proteins, namely, nitrogen gas, ammonia, and hydrogen sulphide. From the carbohydrates some carbon dioxide and a greater quantity of marsh gas are pro-

THE BACTERIAL ACTION IN THE ÆROBIC AND ANÆROBIC PROCESSES



duced. This process results in the reduction of the quantity of solids but leaves a residue or sludge which is tarry in consistency and appearance and is further putrescible. The above chart contrasts the anærobic and ærobic processes.

1. The Cesspool.—A familiar example of the anærobic purification of sewage is the leaching cesspool which is usually built like a well with sides made of large stones between which the water may pass into the surrounding soil. The sewage solids accumulate at the bottom of this tank and are greatly reduced in volume by the septic action of bacteria.

2. The Septic Tank.—Sometimes a tank with tight cement walls is used instead of the leaching cesspool and here there

is an even better opportunity for anærobic action to take place. Here as in the old style cesspool the quantity of solids is greatly reduced but residue must be occasionally removed. Large septic tanks are used in the purification of city sewage.

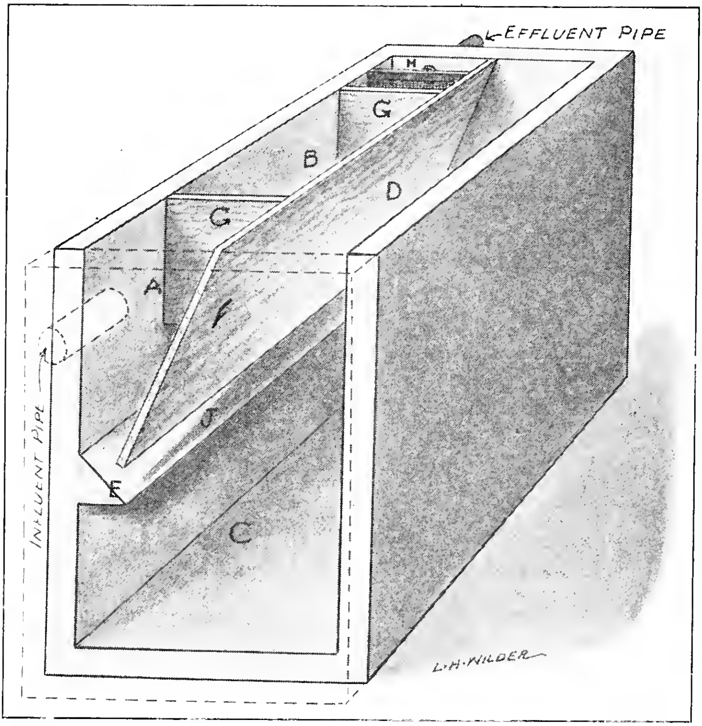


Fig. 40.—Imhoff Tank. The water flows through the upper chambers of the tank *A* and *B*, the flow being reduced by the baffles *G*; the upper chamber is separated from the lower or sludge digestion chamber *C*, by the partition *F*; the solids settle out through the slot *J*, and the gases escape to the right *D*, being separated from the fresh sewage. (Public Health Bulletin No. 101.)

3. The Two-story Tank.—More recently this simple tank has been improved upon and we have had what we call the two-story tank of which perhaps the most important type is that known as the Imhoff Tank. The sewage flows slowly through the upper chamber and the solids settle to the bottom

and pass through the narrow slot into the lower or sludge digestion chamber. It is in the lower chamber that the septic process takes place and there is an advantage over the single story tank in that the gases produced are prevented from passing through the fresh sewage. The result is that the effluent of such a tank has been freed from solids without losing its dissolved oxygen and it is therefore more easily purified further by filtration or dilution. The sludge digests for several weeks in the lower chamber and is finally pumped out, allowed to dry and is disposed of on waste or agricultural land.

Possibilities and Limitations of Sewage Purification.—The above illustrations are intended only to further explain the principle of sewage purification. In actual practice two or more of these processes may be used jointly and other devices like grit chambers to remove the sand, and fine or coarse screens to remove part of the solids may be added. The sewage of a city might pass successively through screens, septic tanks and a trickling filter, after which the effluent might be disinfected with chlorine before being allowed to flow into a lake or stream. The sanitary engineer must prescribe a treatment in each case which is adapted to the sewage itself and to the condition and location of the city.

A good example of purification may be found at the city of Brockton, Mass. Brockton is an inland city of about 65,000 population which is not located on or near any large lake, or river. The sewage is purified by sprinkling filters and then by slow sand filtration, after which the effluent is carried into a small brook. The average daily flow of this brook in summer is only a half million gallons per day, but so completely is the sewage purified that two million gallons of sewage effluent are received daily by the little brook without producing a nuisance. Moreover, studies upon the self-purification of this stream referred to in a previous chapter show that the final processes of purification are carried out so swiftly

by the innumerable plants and animals of the "food cycle" referred to that two miles below the point where the sewage effluent enters, the stream has regained its normal appearance.

It is possible to purify sewage and discharge the effluent into a stream which is soon to be used again as a city water supply provided the second city adopts proper methods of purification for its drinking water. But there is danger that we may go too far in this direction. No one likes to feel that he is drinking purified sewage even though the purification process is complete and the pollution fairly remote. Furthermore, in such a case there is the possibility of a slip in the purification process and the consequent contamination of the drinking water supply. If such a process of purification is

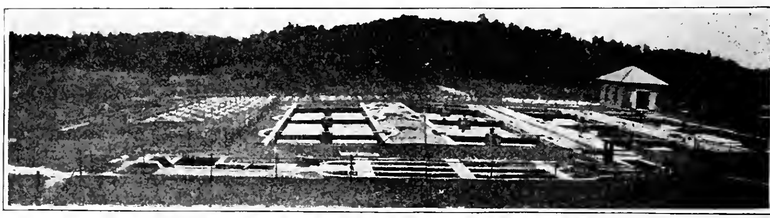


Fig. 41.—Sewage purification plant at Atlanta, Ga. In the foreground there are grit chambers in which the sand is settled out. The water then flows into the large Imhoff Tanks beyond and from these tanks the effluent is carried to trickling filters some of which are seen in action. To the extreme left a sand bed for drying the sludge appears in indistinct outline.

necessary it is certainly much better to have sand filters between the sewage and the water supply than to rely upon other methods of purification or disinfection. A table (see p. 255) has been added indicating the pre-war cost and some of the facts of construction and operation of the more important methods of sewage purification.

Rural Sanitation.—The important problems of rural sanitation, that is, the disposal of wastes in rural communities, cannot be better presented in the available space than by the excellent report of the Committee on Sewerage and Sewage

TABLE OF SEWAGE PURIFICATION METHODS

Type of Treatment	*Pre-War Construction Cost*	*Cost of maintenance*	*Rate of Treatment (or time)*	*Construction material*	*Method of Treatment*	*Bacterial Removal*	*Removal of Suspended Matter*	*Removal of Organic Matter*	*Sludge*	*Effluent*	*Present Use*
Screening	$7000 per m.g.d.	Wide variables		Steel or Copper	Continuous	0-20%	30-50%	10%	Putrid	Putrescible	Not General
Chemical Precipitation	$15,000 per m.g.d.	$5 to $9 per m.g.	4 to 6 hr period	Concrete Tanks	Precipitation	85%	75%	25-50%	Putrid and "Salvy"	Poor	Limited
Sewage Farms	$750 per a.	$6-10 per m.g.	2,000 to 15,000 g a.d.	Gravel Soil	Intermittent Flooding	99%	100%	100%	Porous	Excellent Non-Putrescible	Limited
Intermittent Sand Filtration	$2000 per a.	$10 per m.g. or $50 to $400 per a. per yr.	60,000 g.a.d	4-6 ft. of Sand 0.2 to 0.5 mm.	Intermittent Dosing	99%	98%	95%	Porous	Excellent Non-Putrescible	Common
Sprinkling Filters	$40,000 per a.	$2 to $5 per m.g.	0.5 to 2 m.g.a.d.	5 to 8 ft. of 1.5" Stone	Intermittent Sprinkling	70-90%	0-36%	50-70%	Putrescible	Putrescible	Common
Activated Sludge	——	——	——	Tanks and Filtross Plates	Air-Continuous or Intermittent	80-90%	80%	80%	Stable	Excellent	Increasing
Septic Tank	$775 per m.g.d.	$6 m.g.	6-24 hrs.	Concrete Tanks	Anaerobic Storage	65%	65%	30%	Tarry	Offensive	Limited
Imhoff Tank	$1440 per m.g.d.	$4 m.g.	3 hrs	Concrete Tanks	Anaerobic Storage	65%	65%	30%	Tarry	Putrescible	General
Miles Process	——	——	——	Tank and Sulphur Burner	Acid	99%	80%	80%	Non-Stable	Sterile Acid	Experimental

g. a. d = gallons per acre per day; m. g. d. = million gallons per day.

Disposal of the Sanitary Engineering Section of the American Public Health Association. The following precise and carefully prepared report presented at the October meeting of the Association at New Orleans in October, 1919, is reproduced here through the courtesy of the Association.

It is well known to those who have spent much time in our rural districts that the vast majority of families retain in use the antiquated privy with its menace of typhoid by the contamination of wells and springs, and through the agency of flies; the possible transfer of the hookworm, tapeworm and other parasites by contact through the soil and vegetable life, and with its attendant obnoxious odors.

It is true that among the better class of farmers these conditions are being ameliorated and in many cases really modern and sanitary methods have superseded the objectionable privy; but rural communities as a whole are conservative and progress in such matters is slow.

For instance, it was found upon an inspection by the United States Health Service in 72 towns of populations varying from 500 to 20,000 located in 15 representative counties of 13 different states, but one was "free from grossly insanitary privies." In Connecticut "of the 15 to 20 analyses of wells received in this office (of the State Department of Health) each week, practically 95 per cent show evidence of contamination." In Indiana 60 per cent of the shallow wells have been found impure, and in Wisconsin, which is certainly not a retrograde state in regard to sanitary matters, it has been found that from 30 to 40 per cent of the water supplies on farms contain B. coli, indicating contamination by barnyard drainage.

For this reason the committee has taken *Rural Sanitation as applied to the Collection and Disposal of Nightsoil, Sewage and Garbage* as a fit and timely subject for report. A further reason for its selection lies in the fact that, while there is much valuable literature on the subject, particularly in the bulletins of boards of health, the information remains scattered, unrelated and unstandardized.

It is hoped that by presenting a few typical and inexpensive methods to be followed and devices to be recommended for the disposal of rural wastes from a limited number of individuals and under ordinary conditions, this report may serve a useful purpose as a guide to the householder, physician and local health officer.

The object to be obtained and the methods to be employed may be categorically outlined as follows:

Object

To collect and dispose of nightsoil, sewage and garbage in rural communities:

(a) Without danger to health by
- Contamination of the soil;
- Contamination of vegetables;
- Contamination of water or ice supplies;
- Direct contact;
- Indirect contact (flies, mosquitoes, vermin).

(b) Without the dissemination of offensive or disagreeable odors.

(c) Without offense to sight by
- Lack of privacy;
- Exposure of dejecta;
- Day removal of nightsoil near habitations.

(d) Without breeding or attracting undesirable insects or vermin.

(e) With the maximum of convenience and comfort.

(f) Without unnecessary expense—
- First cost may often be reduced by obtaining expert advice.
- Operating costs may be kept down by providing efficient supervision (effect of frost, repairs, utilization as fertilizer).

Methods

1. Disposal of nightsoil or dry disposal
   - (a) The straddle trench
   - (b) The pit privy
     - Movable or temporary
     - Fixed or permanent
   - (c) The receptacle (pail, tub or box) privy
   - (d) The chemical closet
2. Disposal of sewage or wet disposal
   - (a) The cesspool. No outlet provided
     - Pervious
     - Impervious
   - (b) The tank. Outlet provided
     - Plain settling
     - Septic
     - Imhoff
   - Followed by
     - Dilution
     - Surface irrigation
     - Subsurface irrigation
     - Sand filtration
     - Trickling filters
     - Contact beds and sometimes also by disinfection

(c) The soakage or absorption pit for
Urine
Slops

3. Disposal of garbage
   (a) By filling in land
   (b) By burial
   (c) By use as fertilizer on the land
   (d) By burning
   (e) By reduction for recovery of grease and tankage
   (f) By feeding to hogs
4. Disposal of manure
   (a) By burning
   (b) As fertilizer
   With prevention of flies during storage

With protection from flies or direct contact with excrement provided, there are few methods of disposal in general use that may not be employed under special conditions as to remoteness from habitations, water supplies or cultivated land. Much depends on the climate, the character of the soil and the reliability of maintenance obtainable. General principles remain the same for all, but the application may differ widely between an isolated construction camp, a farm, a military cantonment and the outskirts of a village, and the cost demanded in the last instance would in no wise be justified in the first.

It has not been possible within the scope of the report to go into detail regarding special provisions for camps, schools, fair grounds or communities involving more than a few individuals but the general principles remain the same as for the individual house.

Dry Disposal

Disposal on the surface of the soil is inadmissible from every point of view, inviting transmission of disease germs by accidental contact, through flies, mosquitoes, rats or domestic animals, farm produce and water supplies. There is also the danger of transmitting hookworms where these are indigenous besides being an offense to sight, smell and the sense of decency.

The Straddle Trench is the most primitive form of sanitary provision, and is adapted only to such situations as are found in lumber camps, with mobile troops, etc., remote from habitations. The trench is about twelve inches in both depth and width and of the necessary length. The earth removed is banked on each side, serving as a rest for the feet. After use the excreta should be at once covered with earth several inches in depth.

A more desirable device, but suitable only for secluded locations consists of a cheap and simple *Box Seat* which may be placed over a pit without any superstructure and moved as occasion requires. The box should be fly-tight and the lid self closing, in which case the strictly sanitary requirements may be met provided care is exercised in selecting the location.

The Pit Privy is the simplest arrangement that meets the requirements of sanitation and privacy. If improperly built or located it is a serious menace to health, especially on account of the transmission of pathogenic bacteria by flies, animals and water used for household purposes. If permitted to overflow during storms and contaminate the surface of the ground, the danger is greatly increased. These objections may be overcome by providing:

A pit of proper depth and capacity.

A tight superstructure so designed as to prevent the passage of flies to or from the pit.

A floor above the ground level.

A door and lids to the seats that close when not in use.

Durable screens over all openings for ventilation.

If the pit privy is for use in farms, camps, hunting lodges, etc., far from other dwellings and sources of water supply, the pit may be left pervious, and, when necessary, the superstructure moved to a new location, a pit for which has been prepared in advance.

The pervious pit should never be used in villages or where the contamination of wells or other water supplies is possible. In that case the pit or vault should be given an impervious lining. The structure then becomes more fixed and permanent in character. By constructing the vault in two compartments they may be used alternately for several months. While resting in a ventilated chamber the contents diminish in volume and become easier and less offensive to handle, especially if a little dry earth or, better, lime has been added each time the privy is used.

In general, other wastes than excreta should be excluded from the pits or vaults or privies. If the vault contains much dilute liquid, cleaning is expensive and in warm weather mosquitoes may breed. This may be prevented by adding a cupful of petroleum to the contents every week or two.

By providing a removable box seat the pits of latrines or privies may be burned out at least three times a week, using a gallon of crude oil to fifteen pounds of hay or straw. Otherwise it may be sprayed with a mixture of one pound of lampblack to two gallons of kerosene or one pound of bone-black to three gallons of crude oil.

Screens should be durable, of from 14 to 18 meshes per inch. If painted light blue they repel flies and are difficult to see through from the outside.

The Receptacle Privy, in which a can, pail, box or tray is substituted for a pit or vault, has an advantage in the possibility of placing it indoors if an outhouse is not available, and in the prompt removal of wastes and constant supervision which are then essential. On the other

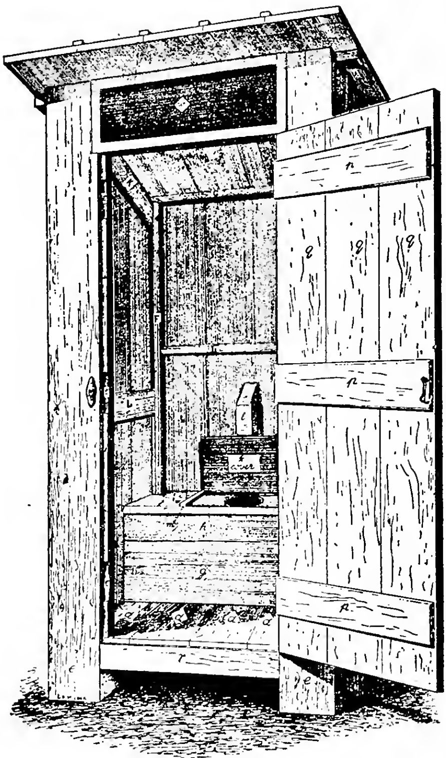


Fig. 42.—A single-seated sanitary privy. Front view. (After Stiles.)

hand, for this very reason, it is less fool-proof than the well-built pit privy and so should be used only when someone can be responsible for its regular care.

The receptacle has a capacity preferably of about two cubic feet. It should be removed at least once a week in warm weather, or when about two-thirds full, and be replaced by a clean receptacle with an inch or

so of sawdust or dry earth in the bottom. It may be handled from inside or from the rear of the privy house, and, in order to prevent the access of flies, it should fit tight directly under the seat, to which position it should be directed by guide strips nailed to the floor.

The use of any but thin paper should be avoided and after use the contents should be sprinkled with lime, ashes or dry earth kept in a box or pail convenient for the purpose. The precautions for ventila-

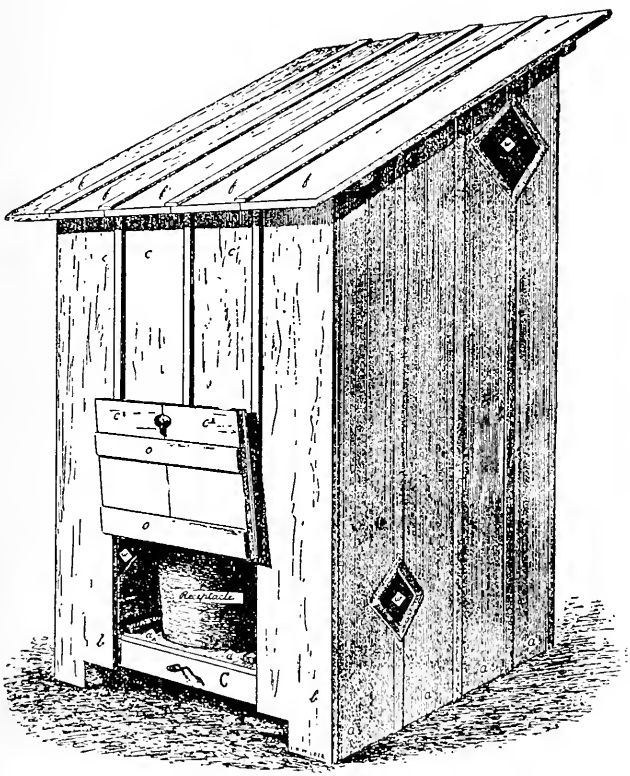


Fig. 43.—Rear and side view of privy shown in Fig. 42. (After Stiles.)

tion, screening, etc., and, if out of doors, the construction of the superstructure are the same as for the pit privy.

To avoid odor the receptacle should be washed when emptied with a 10 per cent solution of cresol and the outside, if of metal, scoured with sand and paraffin.

In military camps or where used by careless persons the seats should be scrubbed daily with soap and water and at least twice a week with a solution of one and one-half ounces of cresol in a gallon of water.

The necessity of providing for the accession of farm hands during the harvesting, berry-picking and canning season is important on account of its bearing on the possible contamination of food supplies. For such situations a receptacle consisting of a long trough which can be inserted under several seats and withdrawn for cleaning may be substituted for the ordinary can.

If the contents of the cans become frozen so as to render emptying difficult, they may be immersed in warm water a few minutes, when they are readily emptied. Otherwise a surplus number of cans should be provided so that when filled they may be stored until thawed out.

The out-door privy should be inconspicuous. A trellis or a few shrubs before the door will secure this end and improve the general appearance of the place as well.

The Chemical Closet is a receptacle privy in which the contents of the receptacle are largely liquefied and sterilized by a strong caustic solution, such as a solution of sodium or potassium hydroxide.

If properly designed and cared for and with proper chemicals it may be placed in any convenient place in the house or elsewhere and therefore, need never be exposed, inaccessible or uncomfortable. Danger of soil pollution or other means of disseminating disease is greatly reduced and it is easily ventilated and cleaned. On the other hand, it requires the attention demanded of any receptacle privy and, in addition, the proper selection and use of the chemical. Where such attention is assured, the chemical closet is well adapted to the use of invalids, schools, institutions and resorts that have no facilities for sewerage.

The final disposal of nightsoil is quite as important as its collection. It should not be accessible to insects, vermin, barnyard fowl or stock, or be liable to come in contact with the human person during or after removal. It should, therefore, never be placed on the surface of the ground.

Where receptacles are used by villages or cantonments removal should be done under some central authority and during transit the nightsoil should be kept under cover.

If a sewerage system is within reach the best plan is to dump the nightsoil into one of the sewers. Otherwise, burial in the ground is usually the simplest and best method. This is sometimes done by plowing a furrow, distributing the material in it and plowing under, but as there is too great a likelihood of imperfect covering in this way it is recommended that this be done by hand.

A preferable method is to dig a trench from 9 to 18 inches deep (24 inches in winter), place the nightsoil in this to a depth of from 2 to 4 inches and backfill at once with at least 4 inches of earth. The bacteria indigenous to the soil at this depth will effectually dispose of the material without offense. This method should be carried out in some well drained sunny field which will not be put under cultivation within six months (twelve months in regions where the hookworm prevails). Such a field should not drain toward a well, spring or other source of water supply. It should be at least 300 feet therefrom or from any dwelling. No hogs, cattle or poultry should have access to land devoted to this purpose. In this way 3,600 cubic feet of nightsoil may ordinarily be disposed of per acre of ground.

Another method of disposal for nightsoil is by incineration with rubbish; or it may be utilized as a fertilizer, preferably first allowing it to rot for a year. These methods cannot be recommended, however, on account of the danger of odor and flies.

To deodorize privies, milk of lime should be added to their contents once a week, but for the *disinfection of nightsoil* a solution of one pound of chloride of lime in five to eight gallons of water, or a 3 to 5 per cent solution of cresol, will be found more effective, using from three-fourths to one gallon per cubic foot of nightsoil.

To prevent the breeding of flies the nightsoil should be sprinkled with powdered borax or, better, a solution of one pound of borax to a gallon of water for every 10 cubic feet of nightsoil, applied once every 10 days.

No privy should be located within 20 feet of a house; within 50 feet of sleeping or eating quarters in a camp or cantonment; within 50 feet of a stream; or, if leaching into the soil is possible, within 200 feet of any body of water that may be used for household purposes, or upon land draining directly toward a well, spring or stream thus used.

Wet Disposal

The Cesspool is, in effect a deep pit privy with a pervious lining. If impervious it is practically a crude form of septic tank and there appears no good reason why a well-designed tank should not be preferred in every case.

Cesspools are usually from 7 to 12 or more feet in depth and the minimum capacity may be placed at about 80 cubic feet. They permit gross pollution of the subsoil and so should be only used in remote regions and where the water supply is brought from a higher level and from a considerable distance, depending on the formation. They should not be used where the ground water stands within 10 feet of the surface, or where, as in limestone regions, natural underground channels may exist.

As with the pit privy, surface water should be rigidly excluded, the structure made entirely flyproof, and the same methods should be applied for disinfection.

The cesspool should be cleaned when filled to within not less than 2 feet of the top. This may be accomplished pneumatically by employing a portable "odorless excavator" which conveys the material to the nearest sewer or to a field for irrigation, but to avoid handling large volumes of liquid that fail to leach into the ground this may be permitted to overflow to a line of subsoil distribution tile or to a specially prepared bed of gravel or cinders, from which it will gradually soak into the surrounding soil.

If used as a fertilizer by irrigating the land this should only be done in dry sunny weather, on pervious land located at a distance of at least a quarter of a mile from any dwelling and on which only trees, shrubs, grain or root crops are cultivated, and where these are not to be harvested within a month.

The Septic tank is the type of tank generally to be recommended for isolated houses having a public water supply and a soil favorable for subsoil irrigation for the effluent. Otherwise resort must be had to some form of dry disposal.

For single houses the capacity, including space for sludge, should equal the volume of sewage to be received in about 36 hours, or say 10 cubic feet for each person.

No surface or roof water should be admitted.

To maintain a favorable temperature in the winter the surface of the sewage in the tank should, if possible be below the frost line.

The tank may consist of two chambers or of a single chamber with baffles, and for small installations it should be covered. Hopper bottoms with sludge outlet pipes facilitate the collection and removal of sludge but usually add to the cost.

Inlet and outlet pipes should terminate from 12 to 24 inches below the surface of the sewage.

Gas vents should be provided.

Only thin toilet paper should be used.

No disinfectant should be employed, but a thin film of oil may be kept on the surface to prevent odor and the breeding of mosquitoes.

The tank should be cleaned annually.

To promote bacterial activity a few pints of sludge from a neighboring tank or a little stable manure should be placed in the tank when first used.

The Imhoff tank is to be preferred to the septic tank for larger installations, such as institutions, hotels, etc., as there is less liability to offense in the disposal of the sludge. The period of retention should

be from 5 to 20 hours, depending on the number of persons served. In other respects the rules given for septic tanks only apply.

The effluent from either type of tank may pass to a body of water that is not used for drinking purposes if conditions for dilution are otherwise favorable, but in most cases it should be first oxidized in some other way.

If it is desired to effect a greater degree of purification than the mere removal of suspended solids, the tank effluent should be subjected to one of the following "oxidizing" processes.

Trickling filters and contact beds are adapted in particular to large installations where the services of an expert are required both in the design and operation.

A special design suitable for use by from 6 to 120 individuals has been recently prepared by the United States Public Health Service, consisting of a grease trap, Imhoff tank, screen, tipping distributer, a lath filter, from 3½ to 6 feet deep having a volume of 8 cubic feet per capita and a secondary Imhoff tank. The whole device is made of wood and for 10 persons is only 13 feet by 5 feet 10 inches by 11 feet 0 inches high. "The degree of purification effected is sufficient for all purposes except where the discharge is directly into a water supply. In such a case chemical disinfection of the effluent is recommended in addition. * * * The plant will operate without a nuisance, and, with a monthly inspection and semiannual or annual removal of sludge from the tanks, will operate continuously without further attention." (Reprint No. 504, *Public Health Reports,* 1919.) Such a plant should be protected from the weather, particularly in cold climates, and its life would be much shorter than if built of masonry.

Another compact device consists of a tank followed by a fine copper screen or sand filter and then a filter of gravel or pebbles through which air is permitted to rise.

Surface irrigation, unless under expert supervision, is not recommended, as offering too many opportunities for the production of odors and mosquitoes and for infection through flies.

Subsurface irrigation by lines of open joint tile laid from 8 to 15 inches below the surface may be the best method to employ provided the soil is not water-soaked or too impervious. The former difficulty is sometimes overcome by embedding the tile in a light fill of sandy soil. The irrigated area should be at least 150 feet from any habitation.

To prevent clogging the soil the sewage should pass through a grease trap at the house and to promote aëration in the soil it should be delivered intermittently from 3 to 6 times a day (somewhat less if the soil is dense) by a siphon contained in a dosing chamber after leaving

the tank. This device may usually be omitted, however, where the house is only occupied during the summer.

The tile should generally be 3 or 4 inches in diameter, laid with a piece of tar paper over the joint and with a gradient of from 2 to 6 inches per 100 feet. The length depends upon the volume of sewage and the character of the soil, varying from 50 to 100 feet for an ordinary family. Where more than 100 feet is required in all it is generally desirable to lay two or more lines of tile. The arrangement may vary with the topography but parallel lines should be more than 6, and preferably 10 feet apart. Unless the soil is quite open the irrigated area may best be operated in two units, dosed alternately. If the land is cropped this should be limited to grains, fodder crops and fruit trees.

Owing to the difficulty of securing uniform distribution of the sewage by reason of the variations in the permeability of subsoil or improper gradients or joints in the lines of tile, and, further, owing to the difficulty in securing any effective drainage when the soil is saturated by storms, there is a measure of uncertainty in obtaining uniformly satisfactory results with this method of disposal; so that, *unless the conditions are favorable and other satisfactory methods are not feasible, subsurface irrigation is not recommended.*

Sand filtration may be used for tank effluents where more than 25 persons are served and where the land is suitable. For this number of persons an area of about 1,500 square feet of bed is required. The filters require careful design and maintenance. Cropping is usually undesirable. Dosing should be intermittent and applied in rotation to a depth of from 3 to 6 inches to two or more beds. In winter the beds should be furrowed to prevent freezing.

Sludge disposal. Sludge from tanks should be dried on porous soil or on specially prepared beds. It should be placed in layers of from 4 to 10 inches in thickness—the thinner the better—until sufficiently dry to be spaded, when it can be buried, plowed under or used as fertilizer. Well digested Imhoff sludge may be used to fill in land. Sludge from secondary tanks,* being difficult to dewater, should be placed on specially prepared beds to a depth of from 2 to 4 inches.

Otherwise, sludge may be drawn off into furrows and covered over.

Fly breeding may be prevented by applying a solution of borax as in the case of nightsoil.

To prevent odor, sludge may be covered with a thin layer of carbonate of lime or "land plaster."

The soakage pit is useful for the disposal of kitchen slops and urine where the water-carriage system is not available.

*Those taking the effluent from filters.

Slops may be spread over the surface of the ground in out-of-the-way locations provided the soil is porous and no standing water remains. Otherwise, a pit about three feet deep filled with broken stone, gravel, sand or clinkers may be prepared to which the slop water is discharged after the removal of coarse solids by a strainer and the grease by a trap. The bed may be covered with a foot or so of earth to bring the top to the ground level and prevent access to insects.

For large volumes a tank and dosing siphon may be employed with advantage, and a system of subsoil tile substituted for the soakage pit.

Where many persons are to be provided for, as in schools, hotels and in the latrines of army camps, urinals should be installed, but for private dwellings a hinged seat that can be lifted is a simpler and suitable arrangement.

Urinals should be flushed with at least a gallon of water daily, and it is desirable that they be automatically fed with cresol or some other deodorant. The liquid can then be led to a soakage pit similar to that provided for slops.

Another plan suitable for camps is to build one or more vertical funnels into the stone filling of the pit to serve as urinals.

Such a pit may be about 3 feet to 6 feet square with 24 inches depth of broken stone or other pervious material on the bottom, depending on the material and the number of persons served. Large installations should consist of several such units.

If preferred, a larger unit, 4 feet by 12 feet by 4 feet deep, adequate for 100 men, may be substituted for the one described.

For emergency use a cone of 6-mesh wire 18 inches in diameter at the upper end, 24 inches long and filled with sawdust will serve without a pit for 6 or 7 men.

Disposal of Garbage

Garbage should be collected without admixture of ashes or other material in metal cans having tight covers, with one always available while the others are being emptied. The cans should be scalded with hot water after emptying.

Garbage is sometimes used to fill in waste land, but for obvious reasons this is not to be approved.

Garbage from households may be satisfactorily disposed of by burial following the rules laid down for nightsoil. Sometimes it is plowed under as a fertilizer, but although it has some value in this respect, the probability of odors ordinarily excludes this as a sanitary procedure. Where odors from garbage do occur the latter should be sprinkled with quicklime.

If without too large a proportion of moist vegetable matter a moderate amount can be safely consumed in the kitchen range, although at the risk of odor; while if the quantity is sufficient, as in a construction camp or a military cantonment, a small but well designed incinerator will eliminate much of this objection.

Burial in summer and incineration in winter, when the ground is frozen and the garbage is less moist, will often be found advisable.

For camps the ''Woodruff Pit'' has been found a satisfactory device. This consists of an excavation in the ground from 10 to 13

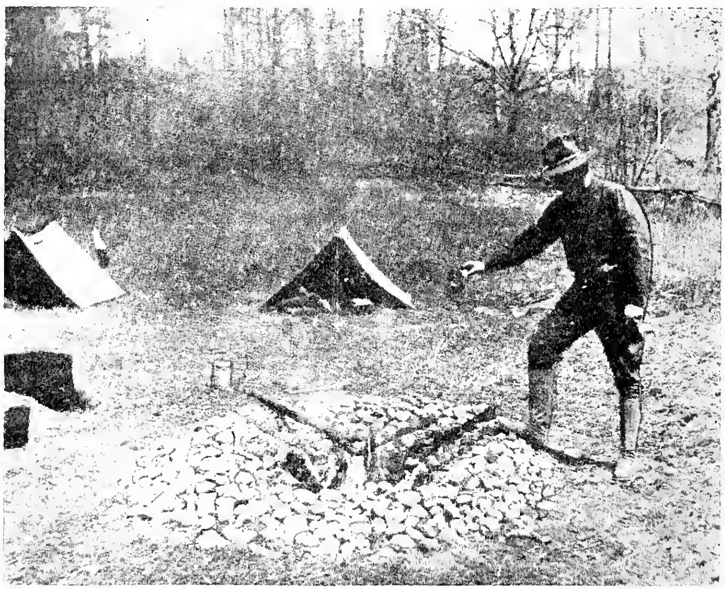


Fig. 44.—Outdoor incinerator (Arnold type). (Gardner.)

feet in diameter and 4 feet deep, lined with fieldstone. A conical pile of stone or a cone of brick with open joints is built in the center around a chimney of two or more lengths of sewer or stovepipe. Garbage and nightsoil placed on a fire built in the pit will usually be readily consumed; but if, on account of wet weather or very moist garbage, a more rapid combustion is desired, this may be had by pouring on a little kerosene oil. Care should be taken to prevent dissemination of papers, etc., by the wind.

Another arrangement consists of a pit 5 by 2½ feet in plan with the bottom sloping from a depth of 6 inches at one end to 12 inhces at the other. The trench is filled with fieldstone or, if these are not available, with tin cans, the excavated material is banked up on the sides and a fire built on top. After the stones are thoroughly heated any liquid wastes are poured in the trench at the shallow end of the pit, in which they are evaporated, and the solid material placed on top where it first dries out and then burns. up.

A certain amount of odor will probably be inevitable with incineration, but with competent operation this need not be serious in the case of camps.

As garbage contains a considerable amount of grease which can be recovered by percolation with some solvent, leaving a tankage with some value as a fertilizer base, this may prove a wise method of disposal where collection can be made from a considerable population; but as the plant required is rather elaborate, this process can seldom be availed of except for large cities. The demand for grease and fertilizer has increased so during the war, however, their recovery should be considered in connection with army camps and cantonments.

Probably the most economical method for the farmer and for towns of moderate size is in feeding to hogs, due care being taken to maintain cleanly conditions about the pens. The garbage should not be kept more than 48 hours in any case before feeding. On account of the possible nuisance from smells and flies the pens should be located, if possible, at least a quarter of a mile from dwellings.

Disposal of Manure

The manure pile is a most prolific source of flies, which find in it a favorable environment for breeding. As it takes about two weeks for the larvæ to develop, these should always be destroyed if the manure is to be kept for a longer period except in cold weather.

Fifty horses will produce a cartload of manure a day. Fly breeding may be prevented by an application of borax, using not over one pound to 16 cubic feet of manure if the latter is to be used as a fertilizer, but a better plan is to sprinkle with a solution of two pounds of copperas per gallon of water, or with a solution of hellebore mixed in the proportion of one pound to 20 gallons of water and applied at the rate of a gallon of the solution to each cubic foot of manure. By consolidating the exposed surface of the manure by battening with a spade it will prevent to a considerable extent the breeding of flies. The heat generated just below the surface by decomposition is then such that the larvæ are largely destroyed.

The most natural use for manure is as a fertilizer, but where this is impracticable it may be piled in windrows about two feet high, saturated with oil and burned.

Of the safeguards against disease in our rural communities those relating to the protection of water supplies and to the transfer of disease germs by flies are by far the most important; so that, whatever method of disposal is adapted to a given situation it should be such that *no excretal matter can find its way, either by percolation through the soil or by surface wash during storms, to wells or streams used for drinking purposes, and that all such excretal matter shall be so protected by screening or otherwise that flies cannot find access thereto.*

In this connection it may be well to point out that when the polluting material lies at a higher elevation than the water surface in a neighboring well there is always the tendency of contamination of the well; but where the source of pollution lies permanently at a lower elevation contamination of the well will not occur.

During the preparation of this report the committee has addressed inquiries regarding the subject treated to the health authority of each state as well as to others and has received in return a large number of bulletins, reports and prints containing information of great value that has been freely drawn upon and for which the committee desires to express its hearty appreciation and thanks.

Respectfully submitted,

KENNETH ALLEN, *Chairman.*
FRANK A. BARBOUR,
GEORGE S. WEBSTER,
T. CHALKLEY HATTON,
LANGDON PEARSE,

Committee on Sewerage and Sewage Disposal, Sanitary Section American Public Health Association.

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CHAPTER XIV

SCHOOL HYGIENE

The Problem.—The duties of organized government in School Hygiene are extensive and important. The state by its excellent compulsory school attendance law places almost a third of our total population in this "factory" for the development of the mind. Dr. Osler has said that most of the diseases which cause death in middle life are developed from conditions begun in childhood. America has been behind the European countries in developing the subject of School Hygiene but the examination of ten million of our population in the selective draft brought home forcibly to the American people the fact that one-third to one-half of our young men are unfit for full military service because of physical defects many of which are correctable. We have begun to face the problem of properly caring for our school children in a serious and right-minded fashion realizing the vast amount of work which lies before us.

The following discussion of this broad and complex subject is intended to give only the outline and general nature of the problem with special emphasis upon those phases of the work in which the dentist is likely to take part. Nor shall we attempt to define the relative responsibilities of the educational and health agencies of the government in this field. Obviously there is both an educational and a health aspect to the problem. The personnel of both departments is necessary and a division of the details of administration must, for the present at least, frequently depend upon local conditions. The question of who does the work is not so important as that the work is done and done properly.

Special Groups of Defectives.—School authorities keenly realize the difficulties in educational progress caused by the special physical, mental and temperamental disabilities from which certain children suffer. These children have defects which make it desirable and in some cases imperative, both for their own good and in justice to the other pupils, that their education be conducted in special classes apart from the public school. Such defectives have been divided into the following eight classes: (Crowley's *Hygiene of School Life.*)

1. Nervous children.
2. Backward children, consisting of two main subdivisions:
    (a) Dull children whose backwardness is due to some accidental cause.
    (b) Dull children with inherent diminished capacity for book learning.
3. Mentally defective children:
    (a) Feeble-minded.
    (b) Imbeciles and idiots.
4. Children with defective vision or blindness.
5. Children with defective hearing, deafness or deaf mutism.
6. Physically defective children, including cripples.
7. Epileptic children.
8. Children suffering from a combination of physical and mental defects, e. g., the blind idiot, the feeble-minded deaf child.

Obviously, the education of these children is a health problem as well as an educational problem, and medical service is necessary in handling the problem of special classes. However, we must leave these specialized problems and confine our attention to the hygiene of the public schools.

The Scope of School Hygiene.—The activities included in school hygiene naturally fall into three groups:

1. Health supervision or the care of the physical well-being of the child.
2. Instruction in Hygiene or the education of the child in matters of health.
3. Proper sanitation of school buildings and grounds, the preparation of proper conditions for study, and the conduct of school work under hygienic conditions.

1. HEALTH CONTROL

The following table presents the scope of the work of the first group in more detail:

1. Medical or health supervision.
   (1) Regular, periodical, physical examination of children.
   (2) Correcting physical defects, eye, ear, nose, throat, posture and nutrition.
   (3) Checking incipient maladies.
   (4) Correcting unhygienic habits of living with follow-up work at home.
   (5) Dental examination, prophylaxis and repair.
      (a) Cleaning teeth.
      (b) Filling six year molars.
      (c) Teaching oral prophylaxis.
   (6) Prevention of Communicable Diseases.

Personnel.—Four types of specially trained people are necessary for the administration of the medical side of school inspection, the physician, the school nurse, the dentist and the dental hygienist.

The *physician* must be a capable diagnostician with a fondness for the type of work and with a public health point of view.

The *school nurse* has a variety of duties in assisting the doctor in the routine of medical inspection, visiting homes and interviewing parents, visiting schools and examining children for infectious diseases, assisting in treatment at the school clinic and occasionally giving instruction in hygiene to the pupils. It is therefore, highly important that she have the ability of making the proper contact with pupils and parents, as well as the ability to detect communicable disease and assist the physician. If she is to instruct in the school she should know something about teaching as well as nursing because they are two distinct professions. It no more follows that a nurse can teach than that a teacher can nurse. The nurse is

the point of contact between the family, the child and the school medical authorities and upon her common sense and practical work often depends the success of the plan. Her failure to secure the cooperation of the parents in having the bodily defects of the child corrected and in maintaining better home conditions means a failure to secure a practical result of health improvement. The woman who can appreciate the problems of the homes she visits adds something to the value of her work which detailed scientific knowledge cannot supply.

The work of the *dentist* may be orthodontia, repair work or prophylaxis but it is work at the chair and not widely different from routine practice.

The *dental hygienist* stands to the dentist in much the same relation as does the nurse to the physician. She must work with the children and perhaps in some instances with the parents. She examines the teeth and fills out a record card, prepares the patient for the dentist and cleans the teeth.

Physical Examination.—Dr. Crowley, of England, who has examined many hundred children gives the following figures indicating the proportion of children having diseases and common defects requiring treatment among elementary school children:

Defects of vision 10%; defects of hearing 5%; ear diseases 3%; marked decay of the teeth 50%; (some decay 80-90%); Tuberculosis 2%; heart disease 1%; malnutrition 10%; ringworm 1%.

The physical examination of the child, however, is even broader than this list of defects and should include a study of cleanliness, nutrition, height and weight, heredity and environment, and an examination for squint, external eye disease, defective hearing, adenoids, ear discharges, enlarged glands, defective teeth, acute rheumatism, chorea, heart disease, lung disease, bronchitis, venereal disease, rickets, anemia, headache, diseases of the skin, and deformities. The following card is one devised by the U. S. Public Health Service for recording the results of physical examination.

.... (Child's surname.) (Given name.) .... (Name of school.) | .... (City, town, or district.) | .... (County.) | .... (State.)

Sex: M. ...... F. ...... Color: W. ...... C. ...... Age ......Date of birth: Month ...., day ...., year 19....

CHILD'S SICKNESS RECORD DURING SESSION

	Sept.	Oct.	Nov.	Dec.	Jan.	Feb	Mar	Apr.	May	June	Total.
Number of days enrolled..................	......	......	......	......	......	......	......	......	......	......	....
Number of days present..................	......	......	......	......	......	......	......	......	......	......	....
Number of days absent—Toothache.........	......	......	......	......	......	......	......	......	......	......	....
Number of days absent—Colds.............	......	......	......	......	......	......	......	......	......	......	....
Number of days absent—Other sickness.....	......	......	......	......	......	......	......	......	......	......	....
Number of days absent—Other causes........	......	......	......	......	......	......	......	......	......	......	....

Child's Scholarship Record: Age at which child commenced school........... What grades were repeated by child prior to this session?........... Grade in which child is enrolled this session .... Character of child's work at school during the present session (mark the proper grading with X): Excellent ...... Good ...... Fair ...... Poor ...... Very poor ...... Was child promoted or failed at the end of this session? .... If child failed this session, what in your opinion were the causes of failure?..................

....

(Above to be filled in by teacher.) (Below to be filled in by nurse.)

Name of parent or guardian .... Occupation .... Remarried: Father .... Mother ....

Father living? ...... If dead, state year ...... Cause of death ....

Mother living? ..... If dead, state year ...... Cause of death ....

Number of brothers living ...... Dead ...... Cause of death ....

Number of sisters living .... Dead ...... Cause of death ....

If child has any of the following diseases during the present session, enter month in which it occurred: Chicken pox .... Diphtheria .... Measles .... Mumps .... Scarlet Fever .... Smallpox .... Whooping cough .... Other diseases causing absence from school (state what and give month of occurrence)....................

....

Any tuberculosis in child's home .... Has child been exposed to tuberculosis in home ....

Vaccination (smallpox) .... No. times .... When last successful (year) ...... Vaccination (typhoid) ...... State year ......

U. S. Public Health Service, Physical Examination of School Children—Child Hygiene Form No. 4.—Revised Feb., 1920. 2—9644

(OVER.)

EXAMINATION AT BEGINNING OF SESSION

Date of Examination ...., 192

Height (with or without shoes) .... ins.
Sitting Height .... ins.
Weight (with or without shoes)—no wraps .... lbs.
Chest expansion: Exp. .... Ins. ....
Hearing (watch): Right .... Left ....
Vision (Snellen): RV .... LV ....
Vision with glasses (Snellen): RV .... LV ....
Teeth, number defective ....
Teeth, number missing ....
Teeth, number fillings ....
Use of toothbrush ....
Enlarged tonsils ....
Mouth breathing ....
Skin eruptions ....
Pediculosis ....
Other defects or deformities ....

Height and Weight Measurements at End of Session.

Date of making ...., 192

Height (with or without shoes) .... ins.
Weight (with or without shoes)—no wraps ....lbs.

(ABOVE TO BE FILLED IN BY NURSE

Date of Examination ...., 192

Defects of auditory apparatus ....
Defects of visual apparatus ....
Trachoma ....
Nasal defects ....
Throat affections ....
Heart disease ....
Pulmonary disease ....
Mental and nervous disease ....
Orthopedic defects and diseases ....
Speech defects ....
Spinal defects ....
Blood parasites—malarial* ....
Intestinal parasites* ....
Skin and scalp conditions ....
Nutrition: Exc. .... Good .... Fair .... Poor .... Very poor....
Mental age ....
Other defects or deformities ....

*Microscopic examination to be made only in suspected cases, but routine in infected localities.

(ABOVE TO BE FILLED IN BY MEDICAL INSPECTOR)

(BELOW TO BE FILLED IN BY MEDICAL INSPECTOR.)

TREATMENT RECORD

Date ....

Nature of defect ....
Treatment advised ....
Date of notification of parents ....
Case treated by .... Date ....
Nature of treatment ....
....
Result of treatment .... Date ....

2—9644 ...., *Medical Inspector.*

This form is more elaborate than many communities are in a position to use. In any case the record card should always be of suitable size for filing and should be made a permanent record so that the health progress of the child may be ascertained at any time.

Treatment.—The defects having been discovered, treatment must be secured. A blank somewhat after the following form may be sent to the parent.

Office Medical Inspector of Schools

....
Parent or Guardian Address
A recent physical inspection of..............................
Name of child
attending the .... indicates the following
Name of school
abnormal conditions:
....
You are advised to take .... to your
Name of child
family physician, dentist, oculist, or to a dispensary for advice and treatment.
....
Medical Inspector.

The examination should be made at the school and the clinical work may be done either at the school or at some building of the Health Department. This work requires special conveniences and equipment. The chart on p. 281 shows the floor plan and arrangement of the medical inspector's room in general use in New York City.

These quarters should be centrally located, preferably on the ground floor, and should have the essentials of a waiting room, proper lighting, an electrically lighted chart and distance of 20 or at least 15 feet for eye examination, a lavatory and table with the necessary filing cabinets for records. The diagram shows a convenient arrangement by which the waiting room space may be used in eye examinations so that a room 12 by 20 feet is made sufficient. In cases where the room is not in constant use it may be used on alternate days

as a clinic. In this case the room should be somewhat larger and might contain as a complete equipment: a desk, wardrobe, medicine cabinet, two chairs, couch, lavatory, scales with measuring rod, electrically lighted vision chart, portable screen and a filing cabinet with the medical and surgical supplies in most common use such as cotton, gauze, bandages (1 and 2 inch), boracic acid, green soap, collodion, tincture of

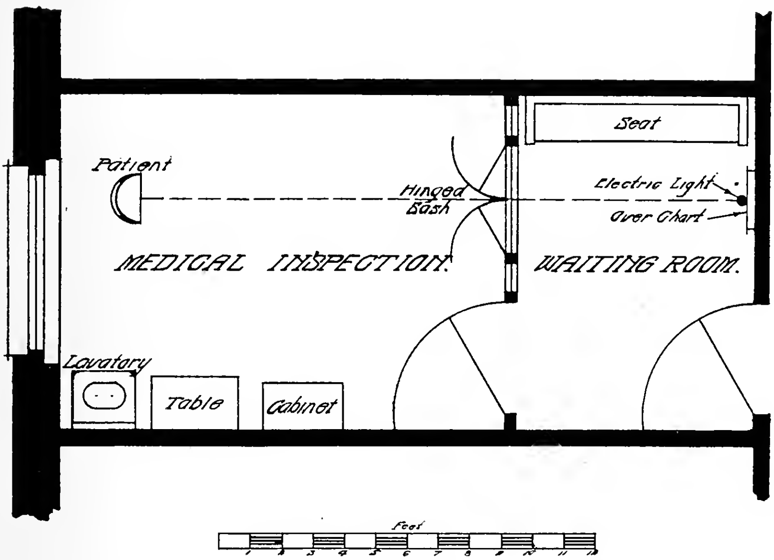

Fig. 45.—Floor plan and arrangement of medical inspector's room generally followed in New York City. By the arrangements indicated, the width of the waiting room may be used in eye examinations and a space 12 by 20 feet is sufficient for both waiting room and examining room. (After Berkowitz.)

iodine, sulphur ointment, white precipitate ointment, vaseline, peroxide, lysol, aromatic spirits of ammonia, hand scrub, tongue depressors, toothpicks, argyrol, cocaine, bichloride of mercury, atropine, alloy, bluestone, yellow oxide of mercury, and nitrate of silver.

Administration.—Perhaps the best way to describe the medical activities in school hygiene is to cite the example of a city which has developed a good system of medical inspection. The

city of Detroit, Michigan, which has a population of 900,000 and a school population of 130,000, has perfected a division of medical school inspection under the Department of Health. The present activities of this division are described in the monthly bulletin of the health department for September, 1919, by Henry F. Vaughan, D.P.H., health officer for the city.

This department has been in operation for ten years and records show that communicable diseases among school children are decreasing from year to year. The department has established a routine procedure for the prompt detection of infectious diseases, for exclusion of cases from school under proper quarantine and treatment and for the prompt return of the pupils to school after the quarantine is lifted. School inspection is done under the medical director who has in charge 50 medical inspectors. These inspectors visit from three to five schools every school day working from 9.00 A.M. to noon. Standing orders have been issued to all teachers by the Board of Education through the agency of the Department of Health to send promptly to the examining room all pupils coming under the following heads: (1) children who were absent on the previous day, (2) children who have a skin eruption or rash, (3) children having sore throat or fever, (4) children having persistent cough or sore throat. The teachers are also instructed to report remedial defects among children in her room such as eye and ear defects, tonsils, enlarged glands, deformities, etc. This places a burden on the teacher which normal school girls are not well equipped to bear as they are trained at present. Either the teacher should have more training in the detection of signs of infectious disease and bodily defects or the nurse should be able to do this work in the school room.

In Detroit the nurse arrives at the school in advance of the medical inspector, and does the nonmedical work, being able to eliminate some of the pupils sent down to her for possible

exclusion from school. All children having returned to school after an absence are questioned and on the average two out of every ten questioned are excluded.

For instance, Johnny tells the nurse that he was absent because he had a sore throat. In answer to further questions Johnny informs the nurse that his mother and two other members of the family are suffering from sore throat. The nurse takes a culture and Johnny is sent home. Later in the day she visits Johnny's home for the purpose of making a more extensive survey. If her suspicions are aroused she telephones to the Department of Health and a diagnostician is sent to the house. If a true case is found immediate measures are taken to quarantine the family.

In this city the nurses are unable to do much work in the schoolroom because they are not yet supplied in sufficient numbers, there being only one nurse to 9000 pupils. Dr. Vaughan believes that the ideal proportion is one nurse for 1500 to 3000 pupils.

The children are arranged in groups for the attention of the medical inspector, so that he finds them in the examining room each with a card properly made out. The children with sore throats are in one group, those with skin rashes in another, etc. The medical inspector takes up the work of the nurse making a diagnosis and giving to the principal a list of the children to be sent home. It is Dr. Vaughan's practice to recognize the presence of two cases of a communicable disease in the same school in one week as an incipient epidemic, in which case the inspector makes an examination or takes a culture of every child in the school. During the school season a physical examination is made of every school child so that defects which are overlooked by the teacher are picked up at that time. All schools, public and parochial, are under the Department of Health Medical Inspectors and an important activity of the general physical examination is the placing of afflicted children in special schools of which the Board of Education now has four types including a school for the blind, one for crippled children, a school for deaf children and four open air schools.

Fig. 46.—The effect of treatment for adenoids upon the general appearance of three children. The upper picture was taken before treatment; the lower, after treatment.

Defective Vision.—Special attention must be given to the conservation of vision and the correction of visual defects, for school life places a heavy strain upon the eyes. The accompanying diagram shows the physical basis of far-sightedness

and near-sightedness as compared with normal sight. In normal sight (emmetropia) the image is sharply focused on the retina. In far sight (hypermetropia) the eye ball is too shallow and the perfect focus of the image would take place be-

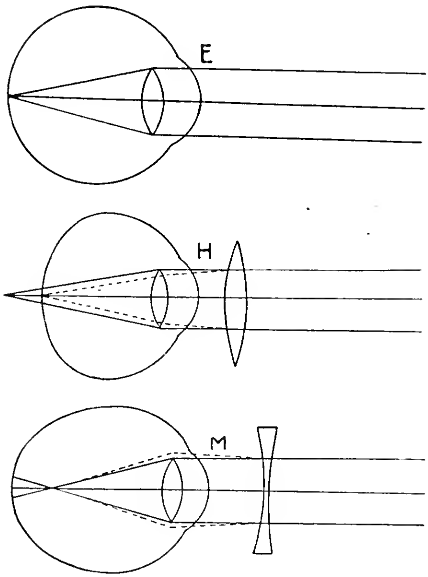

Fig. 47.—Errors in refraction: *E* shows the formation of the image on the retina in the normal or emmetropic eye; *H* shows the condition in long-sight, or hypermetropia, where the eyeball is too short; *M* shows the condition in short-sight, or myopia, where the eyeball is too long. (Pearce-Macleod.)

hind the retina. There is therefore a blurred image and indistinct vision. Hypermetropia is more commonly found in young children and many of these cases tend to correct themselves. However, all cases where eye strain is involved should receive treatment.

In near sight (myopia) the eye ball is too deep and the image is focused in front of the retina. Myopia is a more common defect among older children; it is a more serious condition and should not remain untreated. The amount of myopia increases where there is less occasion to use distant vision.

City children have been shown to have more near-sightedness than country children. The schools themselves may be responsible for some degree of deterioration of vision. This is especially true if the student holds his work too close to the eye. There are many factors which may induce near or strained vision such as insufficient light, light from the wrong direction, a strong light in front of the eyes, faulty position of the pupil in relation to the blackboard, faulty illumination of the blackboard producing shiny surfaces, faulty desks and seats leading to bad postures and bending of the head, and the condition of the child's general health.

Astigmatism is a defect of a different type. In some cases it is of little consequence if no symptoms are produced by it. On the other hand, it may be a very serious defect which of itself is the cause of "eyestrain" with the accompanying headaches and poor health. This is a condition which calls for accurate and careful correction. There are different kinds of astigmatism, according as the eye is, in the vertical and horizontal meridians respectively, hypermetropic, or myopic. In what is known as mixed astigmatism, there is hypermetropia in one meridian and myopia in the other.

The Dental Care of School Children.—No more conclusive proof of the importance of the dental care of school children can be cited than to describe the experience of cities where school hygiene has been practiced extensively. The work at Bridgeport, Conn., under Dr. Alfred E. Fones has been more extensive and elaborate than that in any other American city. It is not out of place, therefore, to consider in some detail the work which Bridgeport has carried out. The total number of children examined and treated in the first and second grades the first year was 6,768. On the first examination less than ten per cent were brushing their teeth daily. About thirty per cent claimed that they brushed their teeth occasionally, while sixty per cent were frank enough to state that they did not use a toothbrush. Ten per cent of the children were

found to have fistulas on the gums, showing the outlets of abscesses from the roots of decayed teeth, and they averaged over seven cavities per child. "It was shocking," writes Dr. Fones, "to find the mouths of these children five to seven years of age in this deplorable condition, and it was appalling to contemplate the conditions that would exist in these mouths as the children grew up. It presented very interesting material to work with." The dentist can draw his own picture of the evil results in the oral cavity and in the system generally when these defects remain uncorrected.

Dr. Fones made the following statement before the National Dental Association in 1917. (*Mouth Hygiene for U. S. Soldiers,* National Dental Association, 21st Annual Session, New York, October, 1917.)

We have tried to work out this plan in Bridgeport, and after three years we find that our educational and preventive dental clinic is the most important part of our school and health systems. Under the plan of this clinic every child undergoes an examination of his mouth and receives a prophylactic treatment of his teeth, accepting it as much a part of the school curriculum as his geography lesson. Every child is taught a method of brushing his teeth and is educated in the care of his mouth just as he is taught physiology or calisthenics. In this way the municipality accepts one-half the responsibility of aiding and educating the children in the prevention of dental decay, while the home care of the mouth and proper feeding is assumed by the child and his parent.

The work of the clinic is divided into four distinct parts. First, the actual cleaning, polishing, and examination of the children's teeth in schools. Second, the toothbrush drills and class room talks. Third, stereopticon lectures for the education of children in the higher grades. Fourth, educational work in the home carried on by special literature to gain the cooperation of the parents. It may be well at this point to make clear to those outside the dental profession what a prophylactic treatment really is. It consists mainly in the thorough cleaning, by means of orange wood sticks in hand polishers, of every surface of every tooth. This means the removal of all stains and accretions on the teeth and especially of the sticky, mucilaginous films known as bacterial placques, which are the initial stage of all dental decay. The importance of removing these placques can thus be readily understood. This work of prevention of dental decay is essentially a woman's work, and to the

dental hygienist it opens up paths of usefulness and activity in helping humanity in masses.

In 1913-14 we trained the first class of dental hygienists in Bridgeport, and two of these women were selected as dental supervisors when our clinic started in the fall of 1914. We had received $5,000 to carry on a demonstrating preventive clinic for the children of the first two grades of our schools, and our corps consisted of eight dental hygienists and two supervisors. In but one year our city officials were so impressed with the results of our work that the appropriation was doubled, the corps enlarged, and a woman dentist added, and now, the fourth year of our clinic, we have a corps of twenty dental hygienists, two supervisors, and two women dentists, and an appropriation of $21,529. The money is appropriated through the board of health and the clinic is conducted by a subcommittee of this board.

Time will not permit giving a detailed report of our clinic from its start in 1914, but it may be said that the system now employed is very similar to that used originally.

The dental supervisors oversee and direct the work of the dental hygienists, give classroom talks, toothbrush drills, stereopticon lectures, and attend to the distribution of literature to children and supplies to the hygienists, and arrange for the moving and location of hygienists in each school.

The work of the dental hygienists consists in making the examination and records of the teeth, giving the prophylactic treatments and instructions in the home care of the mouth.

When the equipment is placed the hygienist begins work for the children of the first grade and takes each grade in succession through the fifth. The charts are made of each child's mouth, one for the parent and one which is a permanent record for the files, showing the conditions found in the mouth for a period of five years.

Aside from the actual cleaning of the children's teeth, the work of the supervisors with toothbrush drills is considered very important, and every effort is made to present this phase of mouth hygiene to the children in a way that will be educational and interesting. It has been quite a problem to secure a good brush that can be sold for five cents, and up to the present time nothing better has offered than factory seconds of a good make of brush.

On the day preceding a toothbrush drill a notice is sent to the parent requesting that the child be allowed to bring his tooth brush to school, and that it be securely wrapped in clean paper. Announcement is made in the classrooms that any child may purchase a new toothbrush for five cents. The drill proper is given with the children seated, while the assistants pass up and down the aisles helping the children to hold

the brushes correctly and to make the right movements. There are four positions for holding the brush and two movements in each drill. The children brush to count in a stereotyped form, it being *intended to teach merely the correct form of brushing and not meant for the actual cleaning of the teeth* which would require running water and dentifrice. A second talk is given up to the care of the brush and the necessity of hanging it in a clean place. The children repeat the drill standing, and the brushes are wrapped in clean waxed paper to be taken home.

It is hardly possible to estimate the educational value of the toothbrush drill in the classroom. It is accepted by the children as a part of the curriculum, and therefore something to be learned and remembered. The teachers have aided in many ways to assist the children in forming the habit of daily brushing.

When the children of the first and second grades receive their first treatment, it is frequently found that while many of the deciduous teeth are decayed, the few permanent teeth erupted at that age are sound, with the exception of the six-year molars. The very first small cavities are just appearing in these teeth, and we believe that the small children entering the prophylactic system should all start on the same basis, that is with sound permanent teeth. We have two women dentists who work with the hygienists in our schools and confine their efforts to the filling of the first permanent molar teeth. We term this preventive dentistry also, as the effort is made to thus prevent the development of large cavities in these, the most important teeth of the denture.

Five years ago Dr. Fones in beginning his work in Bridgeport examined the mouths of the children of the fifth grade. These children had never received any dental attention. In 1919 he again examined the mouths of children of the fifth grade, this being the first class to have received dental care upon entering school. The beneficial results of his work are shown by comparative figures. There was a reduction of caries in the permanent teeth of the fifth graders amounting to 33.9 per cent. This reduction was due in the main to three activities, (1) cleaning the teeth, (2) filling the six-year molars, and (3) teaching prophylaxis and the use of the toothbrush.

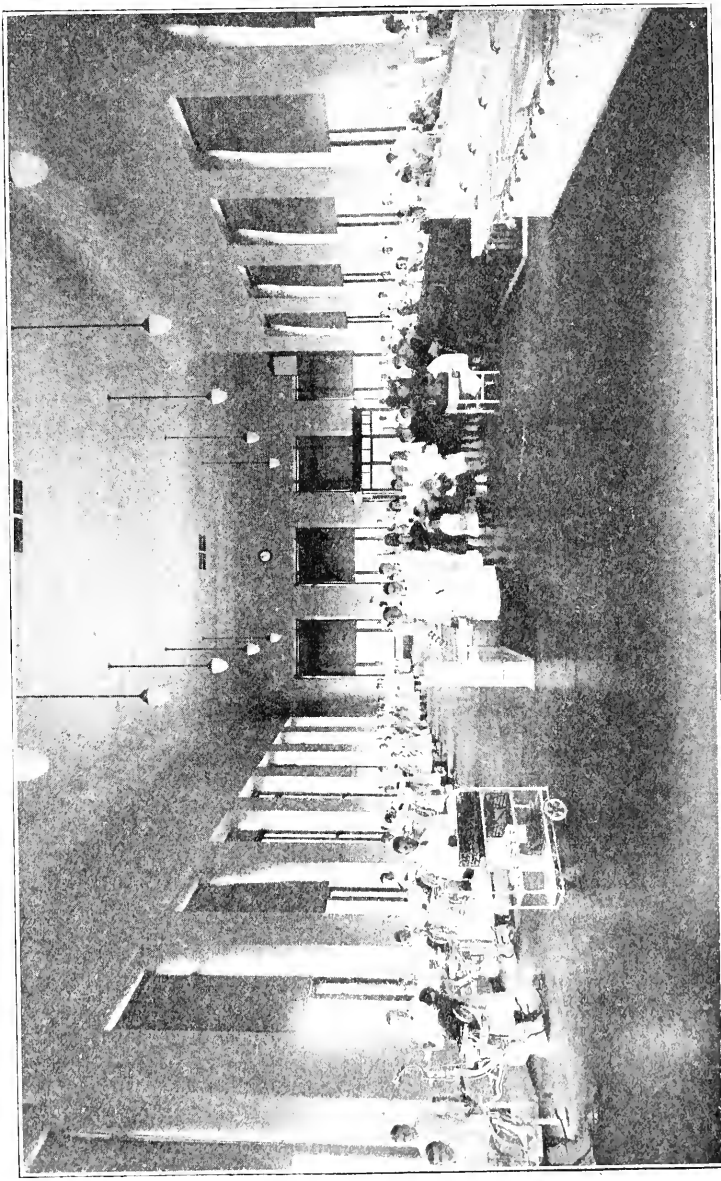

Fig. 48.—Dental Clinic at the Forsyth Dental Infirmary for Children, Boston, Mass.

The following story of the experience of dental clinics in the city of Detroit is told in the September (1919) Bulletin of that city.

Special dental clinics are maintained for school children at fifteen different locations in the city. The clinics are so situated that they will be conveniently near the greatest number of schools. The dental inspection work includes all the schools in the city, public and parochial. The children are sent to the clinics in squads at appointed hours for necessary treatment.

During the school year of 1918-19, the dental clinics accommodated 73,245 children. Of this number, only 8,638 did not need dental attention. The necessity for this inspection work is emphasized by the figures in the report showing that 54,409 decayed teeth were found by the inspectors, the number of permanent molars lost being 9,046. Nine hundred and ninety-two children were found suffering from abscesses, painful and health-destroying. Fifty children had palatal defects.

The Department of Health is unable to reach all the school children, the inspection staff being limited to five dentists, and not all of them serving during the full school year. An attempt will be made by reducing the reparative work and increasing the prophylactic work, to take care of new schools this year. It has been the plan in New York City, where it is impossible to reach all the school children needing dental treatment, to select children from the age of school entrance up to about ten or twelve years. It is known that a child's mouth during this period is in a most transitional stage, and that work done then will have a great effect for good upon the future, or adult, development and condition of the mouth.

Enthusiastic cooperation on the part of teachers and principals of schools has greatly assisted the inspectors in their work. The teachers, particularly in schools where dental educational propaganda has been conducted, say that they have noticed the effect upon the children, especially in what may be termed the improved tone of the pupils' personal hygiene. Care of the teeth is one of the first lessons in body cleanliness.

The teachers and pupils assist the inspectors by collecting and helping to fill out the report cards. When a child is found in need of dental work, the Department of Health sends a card to the parents or guardian, reading as follows:

"Your child needs dental attention. This is the time to have the small cavities filled to prevent future loss of teeth. If you have a regular family dentist, will you please take your child to have these cavities filled while most of them are yet small. If you have no regular

dentist and positively cannot afford to pay for the work needed for your child, you may have such work done without charge in one of the free dental clinics of the Department of Health. If you wish this done, please sign and return this card to the teacher immediately.''

With the opening of the present school season, the Department of Health dental staff comprises fifteen dentists and five dental hygienists. Under a new state law, employment of dental hygienists for dental prophylactic work is permitted, but as yet the department has been unable to interest a sufficient number of qualified dental hygienists, because they are largely employed in eastern cities.

The work done by the dentists in the clinics consists of filling, extraction and operative treatment, together with such lectures and instructions as are necessary. In addition, 69 cases of orthodontia, where the teeth were so irregular and malformed that the patients would suffer serious physical impairment if not attended to, were corrected during the year, 1,444 treatments being given in all.

A free dental clinic is maintained on the third floor of the Department of Health building, 233 St. Antoine street. The quarters are rather small for the volume of work handled. Five chairs are in operation, in addition to an x-ray room and orthodontia room. The little patients are obliged to wait in the hall for their turn in the dental chair.

However, this clinic is popular during the twelve months in the year. In addition to caring for school children, the clinic does work for others who have applied for employment certificates, but who, because of their teeth, cannot pass the required physical examination. Adults wanting teeth extracted or treatment for the ''toothache'' are also given attention.

WORK OF SCHOOL DENTAL CLINICS
1918-19

New cases	16,270
Revisits	22,765
Total visits to clinics	39,035
Prophylactic treatment	12,294
Fillings	14,323
Treatments	7,876
Extractions—	
Deciduous	17,427
Permanent	4,218
Surgical cases	23
Curetment	162
X-rays taken	124

It is found necessary for the physician or dentist in charge of medical and dental school supervision to show the results of his work in reports issued from time to time which will secure for him the further cooperation and financial support of the city. His records should be made and kept with this in view. We have already cited the reduction in dental caries at Bridgeport since the installation of the dental clinic. The Health Department at Bridgeport is also able to show the benefits of medical and dental work in the reduction of the percentage of retarded pupils as shown in the following table:

PERCENTAGE OF RETARDED PUPILS

Grade	Sept., 1912	Nov., 1918	Drop in Retardation
I	16.5%	8.1%	51%
II	37.	15.3	58
III	53.	24.7	53
IV	59.5	31.7	47
V	61.	33.1	45
VI	54.	30.4	44
VII	39.	19.3	50
VIII	27.	12.5	54
Average	40%	20.1%	50%

The cost of reeducation in Bridgeport in 1912 was 42 per cent of the entire budget, whereas in 1918 it was only 17 per cent. A careful examination of conditions showed that the only changes in school management which have taken place during this period which might account for the improvement in the number of promotions are, (1) an effective reorganization of the courses of study which took place in 1915 and (2) the establishment of dental services in 1912 with better medical as well as dental supervision. A clear case is therefore made for the benefit of health improvement and a return on the investment can be measured by the saving in reeducation costs.

The reduction in the amount of certain communicable diseases also can often be attributed to school medical administration. In presenting data of this sort the school doctor and particularly the school dentist must be very careful to claim only what saving can actually be shown to be due to his own work. For example the city just referred to would show a marked reduction in the amount of communicable diseases among school children which is probably due quite as much to the establishment of an efficient system of general health administration with the employment of an exceptionally well trained health officer, in the person of Dr. Walter H. Brown, as to the establishment of special activities in school hygiene. School health and municipal health react upon each other.

2. TEACHING HYGIENE IN SCHOOLS

There are some diseases like typhoid fever, malaria and yellow fever which can be nearly eradicated by sanitation. Influenza on the other hand is an example of a group of diseases for which the greatest hope of control lies in proper personal hygiene. During the epidemic of 1918 thousands of people died because of the lack of knowledge of the fundamentals of home nursing. During this epidemic the visit of the physician and nurse was occasional, at best. Many deaths occurred because the wife or mother caring for the case did not know that the patient with pneumonia must not get up, that he needed nourishment regularly even though he did not want food and that he must take a reasonable amount of liquids. This experience has taught us the need of giving our children a better knowledge of hygiene through the school system.

We have spoken of instruction in mouth hygiene in connection with the work of the dental hygienist. Other habits of hygiene are inculcated by giving the pupil a list of specific directions for his daily routine. The following is taken from an educational bulletin issued by the Board of Health of Bridgeport:

MY DAILY ROUTINE

1. Have a certain time for rising and keep to it.
2. Throw bed clothes over foot of bed.
3. Wash face and hands, neck and ears with hot water and soap. Rinse off with cold water.
4. Brush teeth and gums with clear water.
5. Clean finger nails.
6. Brush the hair.
7. Inspect clothes as to cleanliness and see that shoes are brushed.
8. At breakfast, eat slowly and chew food well.
9. Visit the toilet, washing afterward.
10. After breakfast brush the food from the teeth, using tooth powder or paste.
11. Obey rules about entering school; be on time.
12. Be careful to sit erect and to stand up straight.
13. Drink water at recess.
14. Return home to lunch or dinner promptly and wash hands before eating and brush hair.
15. After lunch or dinner brush the food from the teeth, using a tooth powder or paste.
16. Play in the fresh air after school.
17. Before eating supper, wash the hands and face and brush the hair.
18. Before taking off the shoes to go to bed, brush the food from supper off from the teeth with a tooth powder or paste. Pass a silk floss or thread between the teeth to remove the food there and rinse the mouth with lime water, then rinse with clear warm water. This is the most important time to thoroughly clean the teeth.
19. See that clothes are neatly placed in a chair after undressing.
20. Visit the toilet, washing afterward.
21. Open bedroom window not less than six inches from top and bottom for fresh air. If weather is not too cold, open wider.
22. Be sure to bathe the body not less than twice a week.

Such work succeeds best if the interest of the children is stimulated by the organization of some child health society which has promotions for progress as the child becomes proficient or shows a good record in personal hygiene, advancing the boy from a "squire" to a "page" to a "knight" etc., with corresponding honors for the girls. Children are interested in such an organization when properly administered and they acquire a pride in physical fitness which lasts all through life.

The teaching of hygiene as a part of the curriculum in nearly all of our cities can be improved by making hygiene a personal, interesting and novel subject. Within the last few years we have made a distinct gain in securing text-books which are both interesting and practical. A new organization called the Society for Visual Education and having headquarters in Chicago is able to supply motion pictures on health subjects specially prepared for school children and of high instruction value. Before leaving the grammar school the child should be given not only the principles of personal hygiene but a knowledge of the principles of infectious diseases so that he will respect the authority and activity of the Health Department and have faith in their findings.

In the high school personal hygiene should be continued and perhaps no greater step in improving the health of the nation could be taken than to require of every girl a brief course in the fundamentals of home nursing. Our discussion of school hygiene has already indicated that the normal schools, in completing the training of teachers, could supply them with the ability to do much for their pupils if they trained them in the principles of schoolroom sanitation, the effects of improper ventilation, lighting and heating and particularly in the facts regarding infectious diseases and the bodily defects of children.

3. SCHOOL HYGIENE AND SANITATION

The maintenance of proper school hygiene by securing suitable lighting and ventilation, proper seating and proper habits of work and play in themselves do much to educate the child in matters of personal hygiene.

The dentist is not ordinarily concerned or burdened with the responsibilities for school sanitation. These responsibilities fall upon the health and school departments. We are discussing elsewhere some of the principles of water supply, waste disposal, ventilation, heating, and lighting so that it

is not advisable to go into detail on this subject, for in any case, the public health experts should be consulted and should the dentist find himself responsible for regulating these factors of school hygiene a more extensive work should be sought.

There are innumerable details. Safe water must be provided and distributed through individual cups or by drinking fountains which are so guarded that they cannot be mouthed by the children when they drink. Enough light must be supplied from the pupil's left or from very high at the right and never from the front or rear. The blackboard must receive sufficient light and present a dull surface. No seats should be so far from the light as to make it difficult for the pupil to read. The entrance and cloak room should be sufficiently large and properly ventilated with space for hanging clothes and a place for wiping the feet. The entrance should not be directly on the street and there should be one entrance for 300 pupils. Windows should be regular with small spaces between them and should have small white frames which open easily at the top. Dust should be avoided, in so far as possible, by wiping boards with a damp cloth and by preventing the stirring up of the dust immediately before school or at recess since it takes from fifteen minutes to one hour for dust to settle. The ventilation system should supply a constant change of air at the proper temperature.

The length and width of schoolrooms should be in the approximate ratio of 3 to 2. In room construction, corners should be avoided for ease in cleaning. The walls should be a light green with the upper three feet whitened and the lower five feet may well be of tiling or some such durable material. Ceilings should be kept white and the floor of hard wood kept smooth. Holes in the floor may be filled with a mixture of curd and slaked lime in proportion of five to one. This produces a hard waterproof cement.

The pupil's desk should be selected with care. It should not have sharp corners, it should be easy to clean, it should not interfere with the teacher's view of the pupil, it should be

noiseless and so shaped that the sitting posture is not likely to harm the spine, thorax or the eye. There should be measuring and reseating of pupils in seats of proper size at least two times a year. This is easier if one third of the seats in the room are adjustable since classes vary in the size of pupils. The top of the desk should be on a plane with the elbow. If it is lower than this the spine is injured. The back rest should at least support the lower third of the spine. Spit cups or cuspidors should be provided if necessary.

The toilets should be in a convenient place so that retention which may lead to maiming or weakening the bladder or producing sex irregularities may be avoided. The toilet should be well ventilated and the seat should be sufficiently low and U-shaped. Epidemic vulvovaginitis has been reported in schools as having spread from toilet seats so high that it was necessary for small girls to drag themselves over the front.

Age and Sex Differences.—There are many other facts which must be kept in mind in school administration. The brain of the child grows rapidly until the age of seven. The school life should not be begun before six and then the change should not be abrupt. European examinations (Monnard, at Halle, Germany) show that there is less increase in the height and weight of the child during the first year of school life than in any period up to 14 years of age. This decrease in the rate of growth was not noticeable, however, in children who did not enter school until the seventh year. Hertel, of Copenhagen, found on examination of thousands of children an increase in the amount of illness on school entrance.

Girls from the age of ten to fourteen years are not as strong physically as boys. The Danish Commission examined 16,000 boys and 11,000 girls and found 29% boys and 41% girls, respectively, with sick records. In examining 300 children with spinal curvature in Berlin, Eulenberg found that 13% were boys and 87% were girls. Books should be carried with a shoulder strap like a knapsack and not in one arm. They

should not exceed a fifth of the weight of the body. Studies have shown more illness in schools of two sessions than in schools of one session.

Standards.—The following set of Standard Requirements for School Children issued by the U. S. Department of Labor, Children's Bureau was prepared by a committee of public health experts and adopted at the Children's Bureau Conference in Boston in May and June, 1919:

1. Proper location, construction, hygiene and sanitation of school-houses; adequate room space—no overcrowding.

2. Adequate playground and recreational facilities; physical training, and supervised recreation.

3. Open-air classes and rest periods for pretubercular and certain tuberculous children needing some form of special instruction due to physical or mental defect.

4. Full-time school nurse for not more than 1,000 children to give instruction in personal hygiene and diet, to make home visits to advise and instruct mothers in principles of hygiene, nutrition, and selection of family diet, and to take children to clinics with permission of parents.

5. Adequate space and equipment for school medical work and available laboratory service.

6. Part-time physician with one full-time nurse for not more than 2,000 children, or full-time physician with two full-time nurses for 4,000 children for:

(a) Complete standardized basic physical examinations once a year, with determination of weight and height at beginning and end of each school year; monthly weighing wherever possible.

(b) Continuous health record for each child to be kept on file with other records of the pupil. This should be a continuation of the preschool health record which should accompany the child to school.

(c) Special examinations to be made of children referred by teacher or nurse.

(d) Supervision to control communicable disease.

(e) Recommendation of treatment for all remediable defects, diseases, deformities, and cases of malnutrition.

(f) Follow-up work by nurse to see that physician's recommendations are carried out.

7. Available clinics for dentistry, nose, throat, eye, ear, skin, and orthopedic work; and for free vaccination for smallpox and typhoid.

8. Nutrition classes for physically subnormal children, and the maintenance of midmorning lunch or hot noonday meal when necessary.

9. Examination by psychiatrist of all atypical or retarded children.

10. Education of school child in health essentials.

11. General educational work in health and hygiene, including education of parent and teacher, to secure full cooperation in health program.

CHAPTER XV

INDUSTRIAL HYGIENE

Dental and Medical service is rapidly increasing in industry. Already more than 100 firms in the United States have fairly complete departments of industrial hygiene which include dental clinics. Dental practise in an industry, therefore, is a field which more dentists are sure to enter. For those men the subject of industral hygiene holds special interest. But for the dentist who is sure to continue in private practice industrial hygiene has an appeal from two points of view. In the first place, he is interested in knowing those industrial poisons which have mouth lesions which he should recognize in the conduct of his professional activities, and in the second place he is interested in knowing what proportions industrial hygiene is likely to assume in the near future and the attitude of society, the employers and the employees toward this subject. A discussion of the subject from this point of view naturally falls under three heads: (1) the importance and social aspects of the problem; (2) the health organization of industry; and (3) the industrial diseases to be seen in dental practice.

GENERAL ASPECTS OF INDUSTRIAL HYGIENE

The health of the worker is a fundamental national problem. The great majority of our vast population belong to the group of workers, and the social and economic aspects of the question are interrelated with health conditions. Upon the contentedness of the industrial classes and upon their physical well being rests the stability of our social system. The craftsman of the Middle Ages with an interest in the technique of his work amounting to the professional pride of any genera-

tion, no longer exists. The skill of the hand has been supplanted by the precision of the machine. This change is fundamental, for the laborer no longer secures much of his enjoyment of life from his work but endeavors rather to earn enough to be able to purchase his amusement out of working hours. This important and unfortunate change has deprived the worker, in most cases, of a pride in his occupation and centered his mind so completely upon the financial return that he is not as interested as he should be in the conditions under which he works. To be sure labor of late has, in many cases, demanded better working conditions; but more instances can be found where laborers used unhygienic conditions as a basis of the demand for more wages and not as a basis for demanding better health conditions.

In the Middle Ages the craftsman had joy and pride in his work akin to that of the surgeon or the dentist who is continually improving his skill and technique. The old Guilds maintained a form of accident and sickness insurance; they appointed inspectors to see that the work was properly done and honest labor was their watchword. The craftsman knew the entire process of making the article on which he was working and he knew that his return would be proportional to his endeavor. The broad interests and the social organization of the Trade Guilds reached a height to which the existing labor unions have not attained.

We are probably moving toward a condition of cooperation in industry, but under present conditions it is most difficult to give the workman the old time interest in what he is doing. He knows only a bit of the process of manufacture, the industry is so large that he is widely removed from the man at its head; there is in many cases worse than a lack of sympathy between employer and employee, and the high labor turnover testifies to the lack of interest of the workman in his particular factory. The return of the worker's interest in his work and in the conditions of labor would greatly aid the prog-

ress of the health movement. But the latter movement need not be delayed for the former, for its solution will help to solve the economic problem.

This unfortunate industrial condition of class selfishness in which labor and capital with mutual dislike and distrust both profiteer to such an extent that unskilled or semi-skilled labor receives more money than the average man in the professions, while capital merely adds the cost of increased wages to the sales prices and thereby increases both the value of its property and the rate of its return, is unfortunate from the *economic* point of view. But industrial distrust in place of industrial cooperation is even more objectionable from the viewpoint of health.

It has recently happened, for example, that the labor unions of a great industry objected to the continuation of physical examinations. The reasons given were that physical examinations give an industry the opportunity to spread propaganda favorable to capital among its workers; that there is an opportunity for the industry to discharge "labor" men by declaring them physically unfit; that the bodies of the men are their own and that capital has no right to have an inspection; that the physician who is examining the men will testify against them in court if they have a case against the company for industrial accident; that industries try to secure the goodwill of the general public by expanding the health work for employees.

Physical examination of workers as carried on by most industries, coupled with the attempt to relieve those body defects which are found, is not a selfish move on the part of the industry and such objections as are raised above—and which do not need an answer in a discussion for professional men—would almost make it appear that the desire to broaden the gulf between labor and capital is dominant in the mind of the labor leader who makes these objections. His interest in the welfare of the worker and willingness to improve industrial relations does not appear. It does happen that a healthy

worker, free from bodily defects and therefore more efficient and contented, is more profitable to the industry than the same man encumbered by the body defects with which he frequently seeks employment, but the workman who objects to being made well and happy through the efforts of his own doctor or those of the industrial physician, surgeon or dentist, following the examination which has revealed these defects, comes pretty near cutting off his nose to spite his face.

General Problems.—There are many considerations in the regulation of industry which apply to industries generally and which are regulated both from without by the state and from within by the industrial management and the demands of organized labor. I refer to such problems as the hours of work, fatigue, child labor and women in industry. These questions with their interrelationships have such a universal application that it is the duty of the state, first, to study by observation and research the conditions of employment; second, by careful legislation to regulate conditions in a sane and practical manner and, third, to enforce the law by an efficient organization for factory inspection.

Hours of Work.—The number of hours which an individual may work depends largely upon the nature of this work. If labor were paid on the basis of production and interested in maximum production, it would be possible to arrange for each occupation the hours of labor in accordance with greatest efficiency without injuring the health of the worker. So far as the state is concerned, however, it must deal with industries in large groups and set standards of labor in terms of hours per week beyond which either health or production or both are likely to suffer.

The experiences of the great allied countries during the war have taught us much in this regard and the investigations begun under war conditions are likely to be continued, greatly to the profit of industry. These reports* show a reduction in

**Report of the Health of Munition Workers, Committee of the Ministry of Munitions,* published by His Majesty's Stationery Office, London, 1918.

hourly output during the later hours of the 8, 10, and 12 hour working day, the reduction being greatest in the last instance. The relative benefits of a ten minute rest period in the eight or ten hour day and the great advantages of Sunday rest are described. Perhaps no more striking fact was brought out than the discovery that the weekly production on the six day basis was equal to or greater than the weekly production on a seven day basis.

Fatigue.—Actual and careful studies within industries made by expert physiologists are rapidly producing a new science of industrial hygiene and physiology. The U. S. Public Health Service is making important investigations from which we may hope to learn much concerning the effect of fatigue in increasing the number of accidents, in decreasing production, and in injuring health. The great need in this field at present is further scientific investigation of fatigue in the various kinds and conditions of labor. These studies will show us how fatigue may be reduced by modifying processes, and by selecting the right type of man for each type of work. They will point out the unnecessary causes of fatigue and show what innovations may be made to avoid them.

Child Labor.—Many states already have good laws prohibiting the employment of child labor, but even the best of these states have inadequate machinery for inspection and enforcement. It is to be hoped that the new and second national child labor law may be found to be constitutional and go far toward remedying these conditions. The unrestricted employment of children in industry interferes with their physical and mental development, and moreover, children have been found to be subject to industrial accident and industrial diseases to a greater degree than adults.

Women in Industry.—Special legislation is frequently necessary to safeguard the health of women because they lack strength for undertaking many occupations, and in addition there is a period each month during menstruation and a longer

period at the termination of labor when heavy employment should not be allowed. Most states require that a woman shall cease work from two to four weeks before labor and that she shall not recommence work until four weeks after the birth of the child. Although infant mortality increases directly with the proportion of women working outside the home, it is perhaps unfortunate that states cannot legislate regarding woman's work in the home which, in many cases, is heavy, prolonged, worrisome, and fatiguing beyond that of factory employment but which receives very little consideration and is difficult to remedy.

Factory Inspection.—Factory inspection involves the enforcement of laws regulating ventilation, dusts, gases, odors, temperature, moisture, light, cleanliness, overcrowding, water supply, washing facilities, water closets, lockers, fire prevention, the safeguarding of machinery, first aid facilities, hours of labor, employment of women and children, ages of employment, etc. In many states the enforcement of these laws is under the State Department of Health and enforcement is a reasonable duty of the Division of Industrial Hygiene. In other states, however, it is under a separate Department of Labor and Industries but when so located it demands much attention from the medical viewpoint, especially in these times when so much is being learned regarding poisons and other industrial hazards. No state can be excused for not investigating and trying to lessen the health and accident hazards of the industries within its borders.

Industrial Accident Insurance.—The history of Employers' Liability Acts which originated in Europe and which were later supplanted both in Europe and America by industrial insurance describes a step forward in industrial relations. Under Employers' Liability the workman recovered damages for injury by accident by bringing suit against the employer and it was necessary for him to prove that the accident was due to the fault or negligence of the employer rather than to his own fault or that of a fellow worker. Naturally ill will

arose between the contending parties; the amount of damages granted often depended upon the case and the court rather than upon the extent of the injury; and there was usually a long delay before the stricken family of the injured worker received any benefit.

Society has gradually come to assume that the industry is responsible for all accidents occurring in its processes and that the workman should be paid promptly and in proportion to the injury or incapacitation incurred in the execution of his duties as an employee. Accordingly most of our states have now enacted industrial insurance acts under which the employer insures his liability with the state or with an independent insurance company. Under such a law the employee receives benefits from any accident incurred in the industry and from diseases contracted because of occupation. It is not necessary for the workman to prove that the accident was the fault of the employer since no difference is made between payment in such accidents and in those due to the fault of the worker, unless malicious or intentional. Under this system the workman receives compensation after a waiting period of about ten days; there is no delay or expenditure for court procedure, and the friction between employer and workman is banished.

HEALTH ADMINISTRATION IN INDUSTRY

Health activities in industry are usually carried on under a service department and under the administration of a Service Manager who reports directly to the General Manager. The chart on pp. 308 and 309 used with permission of the Hood Rubber Company gives the organization and activities of one of the most complete and successful service departments in the country.

In industries where the service department has been given a fair trial under tactful and efficient leadership, it has clearly demonstrated its usefulness and both employers and em-

ORGANIZATION AND FUNCTIONS OF SERVICE DEPARTMENT.

SERVICE MANAGER.

FUNCTION
of Service Department:
TO CREATE AN EFFICIENT, HEALTHY, STABLE BODY OF WORKMEN.

EMPLOYMENT.	HEALTH.	SAFETY AND SANITATION.	EDUCATION.	GENERAL SERVICE.
FUNCTIONS	FUNCTIONS	FUNCTIONS	FUNCTIONS	FUNCTIONS
1. Knowledge of Sources of Supply. 2. Knowledge of Factory Requirements. 3. Knowledge of Hours of Work. 4. Knowledge of Wages. 5. Knowledge of Work Environment. 6. Proper selection of applicants by— (a) Careful Interview. (b) Knowledge of past record. (c) Knowledge of Physical Condition. (d) Knowledge of job requirements.	1. Physical examination of Applicants. 2. Physical examination of present employees. 3. Periodic reexamination of defectives. 4. Periodic reexamination of employees exposed to Industrial Hazards. 5. Advise Employment Dept. on placement of defectives. 6. Treatment of Medical cases. 7. Treatment of Surgical and Accident cases. 8. Treatment of Dental cases.	1. Reduction of accidents by— (a) Education. (b) Safeguarding Hazards. (c) Following up of accidents and near accidents. 2. Frequent Factory inspection, by— (a) Safety Engineer. (b) Members of Safety Committee. 3. Report all Accidents to proper authorities. 4. Cooperate with Employment and Health Departments in shorten-	1. Bulletin Board information. 2. General instructions to employees. 3. Circulation of current Magazines. 4. Circulation of Library Books. 5. Instructions in— (a) Health. (b) Hygiene. (c) Care of teeth. (d) Care of eyes. 6. Factory Publication. 7. Girls' War Relief Club. 8. Organization clubs. 9. Americanization Campaign.	1. Supply Store for Employees. (Groceries sold at cost.) 2. Farm. (Vegetables raised and sold at cost.) 3. †Restaurant Service. 4. Supervision of Housing. 5. Supervision of Recreational Activities. 6. Supervision of Benefit Plan covering Sickness, Accident and Death. 7. Supervision of superannuated employees. 8. Supervision of Thrift Activities.

7. General instructions to new employees. 8. Follow up of Service Record. 9. Investigation of Absences. 10. Transfers and Promotions. 11. Investigating of Grievances. 12. Interview all leaving employees. (a) To approve discharge. (b) To check up foreman's reason for leaving. (c) To insure an impartial hearing. 13. Keep adequate individual records. 14. Keep detailed turnover records. 15. Furnish State and Federal records. 16. To act as clearing house for general Employment Work.	9. Treatment of Ocular cases. 10. Prevention of a communicable diseases and epidemics. 11. Cooperation with Employment Dept. and Safety Dept. in investigating absences. 12. Furnishing Employment Dept. with data concerning employees who are leaving on account of ill health. 13. Keep adequate examination and treatment records. 14. Furnish statistics pertaining to Health.	ing periods of disability. 5. Facilitate compensation payments. 6. Keep adequate records and statistics. 7. Supervision of— (a) Drinking water. (b) Ventilation. (c) Lighting. (d) Heating. (e) Toilets and Locker rooms. (f) Janitor and matron service. (g) General sanitary conditions. 8. Elimination of industrial disease hazards. 9. General supervision of working conditions.		9. Legal advice to employees. †Not under Service Organization. Prepared by Robert S. Quimby, M.D., Service Manager, Hood Rubber Co., Watertown, Mass.

ployees have come to regard it as a normal and natural service which the manufacturer should render to the workman under the conditions of his employment. More than that it gives opportunity for the employee to better his own conditions and those of his fellow workers, thus making a job into a career and a mechanical operation into a human relationship. It is a new and proper service from the manufacturer which is bound to develop as has accident insurance and which will soon cease to be resented as "charity" by the workman, provided of course that it is properly administered.

The activities of the service department are seen to be numerous and varied. The service manager must first of all be a good administrator; he must know the industry; he must understand men and he should be familiar with the facts concerning health and sanitation and the principles of health administration. He may be a sanitarian or a physician by training but in any case he is, in a large organization, an administrator and can secure expert services and delegate either the medical or engineering responsibility.

It does not lie within the scope of this volume to describe the multiple activities of a service department. The number undertaken and the details of administration vary widely. The reader is most interested in the strictly medical and dental phases and the discussion will be limited accordingly, allowing only for such comment upon accident prevention and sanitation as will show the close relationships which they bear to health improvement.

Accident Prevention.—Scientific accident prevention has been adopted by nearly all of the great industries where hazards are numerous and it has succeeded because it is practical. It has been demonstrated that by properly safeguarding machinery and dangerous processes and by organizing the men for safety, the number of accidents can be markedly reduced. Accident rates have been reduced 80 per cent in some industries and it is estimated that 25 per cent of this reduction was due to mechanical safeguards and 75 per cent

to thoughtful precautions taken by the men themselves as a result of "Safety First" teachings. This reduces the suffering of the men, makes the work more desirable and it reduces the expenses of insurance and medical attendance.

Safety engineers have often been men without an engineering training but men of good mixing ability who understood the industry and who were able to organize the men into safety committees and follow up accidents to see that the proper remedies were applied for dangerous conditions. It has happened frequently that safety engineers have also been interested in the sanitation of the plant and sometimes to an even broader extent in the health of the men. It is often desirable that a man should be secured for this work whose training enables him to combine sanitation and safety. Trained men will soon be demanded for both lines of work.

Industrial Sanitation.—The duties of the sanitary engineer in the industry are, as in general practise, the provision of water supply and waste disposal to which are likely to be added problems of lighting, heating, and ventilation. Principles involved in these activities are discussed elsewhere and the particular problems of industrial sanitation are not of interest to the dental practitioner. The supervision of eating facilities at the factory will serve as an illustration of the direct relationship between sanitation, other health activities, and the health and efficiency of the employee.

Food.—The supervision of such restaurants as may be maintained in or near industries may logically be mentioned as a part of the sanitation of the industry but the food problem is more than this. Of course the sanitation of the restaurant, the physical examination of food handlers, clean, pasteurized milk, adequate dish washing facilities for complete sterilization and sanitary wash rooms and toilets for food handlers must be provided. But the food problem does not end here.

In the steel-ship industry the author found that among 60,000 men in about 40 shipyards from 66 per cent to 90 per cent brought their lunches. These lunches were eaten cold

and in most cases were not balanced from the dietetic standpoint. Moreover many men who bought lunches at the cafeterias paid fifty cents for their lunch, selecting nothing but desserts and many of these were of the pie crust and whip cream variety with relatively little nourishment. In this industry it was possible to secure improvements by placing custards, bread puddings, blanc mange, and other nourishing foods on the list of desserts and by placing booths at various points about the shipyard from which hot coffee and hot stew were served in sanitary individual containers to supplement the cold lunches brought from home.

By enlisting the help of the community health organizations in the food program, it was possible to secure practical demonstrations of how to prepare suitable lunches with a saving in expense, and further suggestions were supplied through columns of the monthly paper issued by the industry. The results of the campaign were most gratifying and the incident illustrates how sanitary and medical supervision, health education and the cooperation of the shop committees, the management and the health interests of the community must often combine for a health improvement.

Medical Activities.—The medical organization of an industry is to maintain the health of the working force and its object is threefold; first, to care for the man who becomes sick or injured while at work; second, to detect and correct defects which are remedial; and third, to detect diseased conditions in new employees which would endanger their own lives or those of their fellow workmen thus making it possible to temporarily exclude or restrict the employment of this type of worker. This very important function is mentioned last because many medical departments exist where there is not as yet either a physical examination upon employment or a periodical examination of the workers. The United States, our greatest employer, has recently examined what was at the time its most important group of workers (soldiers and sailors) and has attempted to remedy some of the physical de-

fects found. These men were picked from the age groups in which they are supposedly most vigorous and even then from one third to one half of them were unfit for full military service. The following are the physical defects found:

TABLE SHOWING CAUSES FOR DRAFT REJECTION

CAUSES	PER CENT ALL REJECTIONS
Total rejections, for all causes	100.00
Alcohol and drugs	.43
Bones and joints	12.35
Development defects (height, weight, chest measurements, muscles)	8.37
Digestive system	.53
Ears	4.38
Eyes	10.65
Flatfoot (pathological)	3.87
Genitourinary (venereal)	1.33
Genitourinary (non-venereal)	1.35
Heart and blood vessels	13.07
Hernia	6.04
Mental deficiency	5.24
Nervous and mental disorders	5.07
Respiratory (tuberculosis)	8.67
Respiratory (nontuberculosis)	1.67
Skin	2.68
Teeth	3.16
Thyroid	1.76
Tuberculosis (of parts other than respiratory)	.88
All other defects	3.06
Cause not given	5.44

The industry is in much the same position as the government. It not only owes to the individual compensation for accident or illness acquired as a result of his occupation, but it also owes to the individual a knowledge of his physical condition, and the applicant should be so placed in the industry as not to aggravate his physical condition. It owes to the workers already in the plant protection against the entrance of infectious disease.

A great service can be rendered in improving the health of the industrial class by offering free medical examination. The workman is warned of a defect while it is still remediable and the young man is impressed with the importance of health when he looks forward to a physical examination as part of the process of "getting a job!" It may seem to the private practitioner of medicine and dentistry that the individual should merely be apprised of his physical condition and that he should seek medical treatment outside the industry. This, of course, is what happens in a great number of cases. The worker always possesses the right to choose his physician and mode of treatment and frequently prefers to go to his family physician or dentist. On the other hand, however, there is no reason why the industry should not, if it chooses, offer to the workman medical and dental care free or at slight cost. The industry can frequently afford to do so as there is less lost time for the industry and for the employee when treatment is given at the factory.

The employee is insured against industrial accidents and industrial diseases and there is no obligation upon the industry or the insuring company to treat anything more than accident cases. Even where there is not a well organized service department, however, it is usually the policy to treat employees for minor ills such as headache, toothache, stomach cramps and the like, for which it is known they would not be likely to consult a physician.

An example of the value of a medical department may be seen in the experience of an industrial establishment (*Modern Hospital,* July, 1919) which offered optional physical examinations under the supervision of the Life Extension Institute beginning in May, 1915. Seventy per cent of the workers were examined and examinations were repeated in the three succeeding years. Later it was made compulsory for new employees. Out of 599 examined, only 5 were found to be normal; 594 required advice regarding their living habits or physical condition; 377 were directed to a physician, and of these 317

were not aware of any impairment whatsoever. The employees who, by later investigations, were found to be carrying out instructions numbered 361; those carrying them out partially, 66; those making plans to do so, 12; those who had done nothing, 160. Hence 439 of the employees have, or will have been benefited. Poor eye-sight, teeth, heart disease, and incipient tuberculosis are particularly mentioned.

If the industrial physician or dentist is efficient and understands his position and the relationships of his department to the workmen in the plant, the medical department is an aid to the industry in many ways. The industrial dentist and physician may be nearly or completely engrossed in administering professional services which only slightly differ from those of private practise, although there are certain industrial diseases with which both must be familiar. However, to be successful each must carry, in addition to his professional knowledge, the ability to command the friendship and respect of the men who come to him for treatment and to impress upon his patients the value and propriety of the sort of work he is doing. The dentist must not allow the false idea to exist that the dental clinic is a "patronizing" activity. It is a function of the industry to which the workman is entitled and it can only be successful by an appreciation of its usefulness and by the cooperation of the workmen in the factory. The policy of the hospital and clinic must be clearly established and thoroughly understood by the medical and dental personnel and by the management, and this policy must be strictly adhered to. The same dignity should be maintained as in private practise and under no conditions should the clinic become a place for loitering or for unreasonably frequent visits by employees.

Industrial Dentistry.—It is not difficult to prove the need of dental care for the industrial worker. In examining large groups of industrial workers, it has been found that 90 per cent or more of such people have dental defects. Thousands of men were excluded from general military service because

of dental defects, and it is no wonder that now—when an increasing number of bodily defects are found to be due primarily or in part to local infections about the teeth—the importance of expert dental services begins to receive general recognition.

The dental clinics which have been established in various industries are not uniform in their methods of administration. The dentist may be full time or part time. Some industrial clinics give only an examination and the dental work is done by an outside dentist. Some give examinations and clean the teeth and some not only give examinations but the additional services of cleaning, filling, extraction, bridge, crown and plate work. Some even go so far as to give free dental services to the children of employees. In other industries dental work is not free but at the employee's expense although it may be done in the company's time. In still other industries where physical examinations are given by physicians, an arrangement is made with an outside dentist or dispensary to do the dental work for the industry at a reduced cost.

The description of the dental clinic at the home office of the Metropolitan Life Insurance Company as described by Dr. Lee K. Frankel, is very interesting and instructive. (Taken from *"Industrial Medicine and Surgery"* by Harry E. Mock.)

The clinic was opened July 1, 1915. The equipment was the best obtainable. It included:

Four S. S. White-Evans-Forsythe Dental Units, which consist of chair, bracket, engine, cuspidor, and compressed air attachment.

Four S. S. White Lyons operating stools.

Four electric spray heaters.

One Ritter Columbia dental chair.

One Ritter dental engine.

One electro-dental switchboard.

One Waugh radiographic machine and lead screen.

Two sterilizing outfits.

Four small cabinets.

One large dental cabinet.

One metal and glass linen cabinet.

Complete set of instruments, towels, bibs, etc.

It was planned that the work should be limited to a careful examination and cleansing of the employees' teeth each six months. The results of the examination are charted and copies of the charts are given to the employees, indicating what subsequent treatment will be necessary by their own dentists.

A follow-up system was inaugurated to ascertain whether the necessary attention is given. No attempt was made to require or compel employees to come to the clinic. From time to time addresses were delivered by the dentists in charge to the employees, indicating the value of proper care of the teeth.

There are approximately 5,000 employees in the company's service at the home office; 2870 treatments were given to 2707 patients in the first six months, July 1, 1915 to December 20, 1915. In the second six months 3383 treatments were given to 2843 patients. In the first six months the average time required for examination and cleansing was approximately sixty-six minutes. With the experience gained by the dentists in charge, this was reduced so that in the second six months the average time was forty-nine minutes. The average time required is constantly decreasing. Viewed month by month this is shown very clearly. In January 1916, the average time was sixty-three minutes, in February fifty-four minutes, in March fifty-three minutes, in April forty-eight minutes, in May forty-seven minutes, and in June thirty-five minutes.

The clinic is in charge of Dr. Thaddeus P. Hyatt, who has under him four assistants and a radiographer. Seven women are employed in the dental clinic as assistants to the dentists, as telephone operators, in the sterilizing room, etc. All the dentists are full-time employees with the exception of Dr. Hyatt. The service given to the employees is free and on the company's time.

I am giving you, herewith, the statistics for the second six months, namely; Jan. 1, 1916 to June 30, 1916, as these are probably more indicative than would be those in the first six months of the service. In this time prophylactic treatment was given to 2315 patients and emergency care to 528 additional patients, making a total of 2843 patients cared for in the period. The average time for emergency cases twenty-one and one-half minutes. Under this term is included: treatment for abscess, pyorrhea, exposed pulp, gingivitis, pulpitis, pericementitis, infected tooth socket, toothache, and extractions and consultations.

The cost of the entire service was $7,229, or an average of $3.00 per hour, and an average per patient of $2.33. Subdividing the prophylactic work from the emergency work, the cost per patient for the former was $2.46 and for the emergency work the cost per patient was $1.06. Assuming that employees accept service of this kind each six months, the

cost per treatment per patient per annum would, of course, be double the figure given per employee treated.

The results even this far obtained are of considerable interest: of the clerks who appeared in the first six months, 1636 who showed cavities on the first examination reappeared during the second six months. These clerks on the original examination had 7,753 cavities or an average of 4.6 cavities per person. During the interval between the first and second examination 916 clerks (56 per cent) out of the 1637 who had cavities had 2936 fillings made, or an average of 3.2 fillings per clerk.

There are other evidences of improvement although they are not of such importance. At the time of the first examination 3.9 per cent of the clerks did not use a toothbrush. At the second examination it was found that this had been reduced to 2.9 per cent. At the time of the first examination 32.9 per cent of the clerks did not show clean mouths. At the second examination only 22.5 per cent showed such condition.

The dentist must realize keenly any special dangers to the teeth which may be inherent in the various processes of the industry, and it is his duty by both prophylaxis and education to safeguard the worker's health in this respect. Frequently an employee reports to the hospital with what he believes to be an industrial disease when in reality he is suffering from systemic effects arising from decayed or abscessed teeth which may or may not have a relationship to the industrial process in which he is engaged.

Disease Prevention and Health Education.—Every member of the medical department should appreciate the value and saving of disease prevention. And this activity must have the hearty support of the men in the industry if it is to be successful. Just as 75 per cent of accident prevention depends upon the Safety Organization of the workers, so health is acquired, maintained or lost by the individual. Health is like salvation; no one can secure yours for you. Health education in industry should not be built from the top down but from the bottom up. The general manager cannot limit preventable disease but the willing cooperation of the workers can do it. The health expert in industry who can interest and organize the men and women of the factory for health betterment both in the shop and in the community will ac-

complish more than a reduction in the morbidity rate. For after all life is not a matter of the pay envelope and the more men and women of the industrial class are interested in the conditions of the home, the conditions of labor, the health and welfare of their families and their fellow men, the more efficient will be our industries, the more stable our population, and the more intelligent our government.

INDUSTRIAL DISEASES

The dentist should know the industrial diseases which have mouth lesions and the industries in which they occur. In the case of those industrial poisons which like acids hasten the decay of teeth, it will naturally be the part of a dentist employed in an establishment to prevent the injurious effects of the harmful substance by keeping a careful and continual watch over the dental conditions of the men in that branch of the industry and by prophylaxis and instruction to teach them to avoid the dangers incident to their work. We shall briefly discuss the important industrial diseases which have mouth lesions; but the dentist who is working over people employed in trades where any one of the industrial diseases exists would want to consult the references and study such diseases in much greater detail.

Lead Poisoning.—Lead is a common cause of serious poisoning. It is not readily eliminated from the body and even small amounts which are swallowed or absorbed through the respiratory tract or the skin soon accumulate in serious quantity. One of the early symptoms of lead poisoning which may be seen even before serious physical defects are noticed is the blue line on the gums. This is usually a double line: a line upon the teeth just below the gum which may be removed by washing and another line upon the gums themselves and consisting of lead sulphite which has been thrown down at this point. The susceptibility to lead poisoning varies and young adults are most susceptible, women being more susceptible than men.

Lead is poisonous in almost any form although the soluble salts like the carbonates are more dangerous than the insoluble salts like the sulphates. For this reason, lead carbonate is eliminated from industries wherever possible. The most common methods of poisoning by lead are by the inhaling of lead dust, or by swallowing lead which is carried to the mouth in various ways by the hands. Absorption of the soluble lead salts through the skin may take place but this type of poisoning is relatively unimportant.

Other symptoms of lead poisoning include restriction of the secretion of saliva, a sweetish taste in the mouth, weakness, weak pulse, constipation, high blood pressure and anemia. Later developments may include wrist drop and encephalitis, which appears as an acute insanity. This poisoning is particularly dangerous where women are employed.

Phosphorus Poisoning.—A serious disease resulting from phosphorus poisoning is known as "phossy jaw." There is an extremely painful inflammation of the jaw bone in the early stages which later becomes chronic and produces a localized degeneration of the bone. The phosphorus produces either a septic gingivitis by inflaming the gums or an active inflammation by acting through decayed teeth. In either case there is soon pus formation in the swollen gum and the painful jaw bone. There are two kinds of phosphorus; the white or yellow which is highly poisonous and the red or amorphous which is practically nonpoisonous.

Phosphorus poisoning was most common in the match industry but the modified methods of making matches have fortunately nearly eliminated the disease. In place of the old-fashioned phosphorus match we have a match made with the nonpoisonous sesqui-sulphid of phosphorus. The "safety match" contains potassium chlorate or chromate with other oxygenous substances and is scratched on a special surface which contains antimony sulphid and red phosphorus. Phosphorus poisoning still occurs where certain special processes —like the manufacture of bone black, phosphates or rat poisons—are carried on.

Mercury Poisoning—The indications of mercurial poisoning are ulcerations of the gums, loosening of the teeth, pain and swelling in the salivary glands, headache, anemia, tremor of the muscles, depleted breath and dizziness. Frequently the molar teeth are lost and the other teeth are black and eroded from the acid solution.

Mercury is absorbed through the respiratory system, the skin or the digestive system. Edsall has cited cases in dentists who had the habit of working their amalgam in the palm of the hand and thus absorbed mercury through the skin. Poisonings most frequently occur from the amalgam used in separating gold and silver ore and from the mercuric nitrates used in the fur dressing industry.

Benzene Compounds.—Among the other substances which produce mouth lesions may be included benzene which sometimes produces a chronic poisoning with pupuric hemorrhage of the mucous membranes of the mouth and throat. Aniline and nitro-benzene both produce a definite cyanosis of the lips and face usually spoken of as the "blues." These and other benzene compounds produce serious effects upon the nervous system. The poisons do not affect the teeth, but they might be detected in the dental practise and referred to a physician.

Acids.—The metallic acids are used in many industries and unless suitable care is taken they produce serious effects by dissolving the dentine of the teeth. Hydrochloric, sulphuric and hydrofluoric acids are the most common offenders. Picric acid in addition to its injurious effects upon the teeth produces an inflammation of the mucous membrane of the mouth.

Protection Against Industrial Poison.—It has been seen that some industrial poisons are given a greater opportunity to act where defective teeth are present, but in addition to putting the teeth in first class condition there are other measures of precaution which need to be taken to protect the the industrial worker. These include proper instruction concerning the nature of the industrial hazards, the installation

of suitable ventilation to remove dust and fumes, the installation of wet processes for dry and dusty ones where possible, the use of proper protective clothing, and the liberal use of washing facilities which should be adequate for the working force. For a consideration of these matters, the reader must consult a more extensive work on the subject of Industrial Hygiene.

CHAPTER XVI

VENTILATION, HEATING AND LIGHTING

The ventilation, heating and lighting of a man's place of work and his home directly affect his health and the health and comfort of his family. The professional man often fails to realize that the poor ventilation and lighting of his office increases both the discomfort and the irritability of his patients or guests. Everyone at some time or other has felt the oppressiveness of the air upon entering a poorly ventilated room. We are sensitive to certain changes of temperatures and barometric conditions. We appreciate the unusual fatiguing effect of a day's work in an office when the ventilation is poor, and we have high regard for the stimulating effect of outdoor life at the seaside or in the moutains during the summer. Everybody knows that there is a difference between good air and bad, but too few people know in what that difference consists and still fewer people have the energy and courage to insist upon suitable ventilation in office, home or public buildings.

GOOD AIR DEFINED

The old idea that the quality of air is determined by its chemical characteristics has been found to be wrong. As children most of us were taught that bad air was air poor in oxygen and loaded with carbon dioxide. It was thought that poor air must contain too little oxygen to supply the demands of the body, and that carbon dioxide acted as a body poison. Recent physiological experiments have shown that, contrary to the former belief, it is the physical and not the chemical character of the air which determines its quality. A comparison of the oxygen and carbon dioxide contents of outdoor air, exhaled air, and the air of poorly ventilated rooms shows the reasonableness of the discovery.

OXYGEN AND CARBON DIOXIDE CONTENT OF DIFFERENT KINDS OF AIR.

	Oxygen	Carbon dioxide
Composition of pure air	21%	.04%
Air in the lungs	16%	5.00%
The air in the worst ventilated rooms	19%	.40%
Composition of air which chemically produces physiological injury	14%	3.00%

It is to be noted that there is a wide difference between "close air" and air which produces injury by virtue of its chemical composition. Even in the worst ventilated room the air is chemically much better than that in the lungs.

Until very recently little attention was paid to the effect of air upon the skin, although now we recognize it as most important. It is hard to believe that the soft free air can make us uncomfortable by its contact with a thick tough structure like the skin until we realize that our skin not only receives the external contact stimuli but also helps to regulate the body temperature as it is acted upon by the air from without and the nervous system from within.

It is easy to forget that the skin is a sense organ, for unless we are either chilled or perspiring other more important thoughts and stimuli crowd these minor sensations into oblivion. It is like the ticking of a clock to which we have become accustomed. We work in the room and are not conscious that the clock is present and yet if it stops we are immediately aware of it.

The movement of air against the body produces definite sensations as it is easy to demonstrate. Step from the breezy porch of your summer cottage into a room with the doors and windows closed so that there is no movement of the air. Sit for a few minutes quietly and then return to the porch and see if the breezes do not have a pleasing and stimulating effect. The deadening effect inside the room was due to the fact that the air immediately about the body, *the aerial blanket,* was not being rapidly changed. There was very slight movement of air in the room and the clothes held this

"blanket" closely wrapped around the body. If we go out from a warm room in winter weather we notice a definite and marked reaction of the skin. Similar but lesser reactions are continually taking place in adjusting the body to the changing condition of air and no doubt the body receives an important stimulation from this gentle playing upon the nervous system by the changing air.

These considerations are in harmony with the results of experiments conducted by the New York Ventilating Commission and by other investigators. For example, a man is put in a closed box where the air is hot and moist. A feeling of discomfort soon develops which cannot be relieved by feeding the man air from the outside by means of a tube passed through the wall of the box. The symptoms of discomfort *are* relieved by turning on an electric fan inside the box, even when the subject breathes the air from within which has been vitiated by continuous breathing. On the other hand, a man sitting outside the box in air of proper temperature and humidity is not injuriously affected by breathing through a tube which supplies him with air from within even though it is vitiated, hot and moist. The effect is on the skin not on the lungs.

Experiments have failed to demonstrate the presence of any injurious organic substance or "crowd poison" in breathed air although it has been found that disagreeable odors produce a depressing effect upon the appetite.

We deduct from the foregoing statement that the most important problem in ventilation is a suitable change of the aerial blanket, and that moving air of the proper temperature and humidity, the wearing of clothes which allow reasonable ventilation to the skin, and the use of water and air baths to keep the skin clean, are the primary considerations. The important considerations in air supply are a comfortable temperature and a suitable humidity. It is indeed foolish for fresh air cranks to advise poor people to suffer with the *cold* because they "need to have the windows open to secure fresh air."

Temperature.—If we examine the effect of different temperatures upon the body, we find that if the temperature is between 80° and 100° F. the body adjusts its heat-regulating mechanism so that it just keeps pace with the loss of heat from the body by the evaporation of perspiration and by heat transfer, (i. e., radiation and conduction). The optimum temperature is 68° F. Slight variations from this temperature will not quickly call the heat-regulating mechanism into operation so that discomfort may be felt between 60° and 75° because it is neither so warm as to start active perspiration nor so cold as to require active movement. If the temperature is below 65° and above 40° such a chilliness is felt that if the person is free to do so he will move about and thereby increase the body temperature by greater oxidation. It has been suggested that the feeling of discomfort arises from the difficulty which the heat-regulating mechanism is experiencing.

Moisture.—What effect does the varying moisture content of the air have upon the body? We know that water is a good conductor of heat and therefore if the air is moist and cold it will seem very chilly because the heat is conducted away from the body rapidly, even though the skin has reacted to the low temperature and reduced the evaporation of moisture. On the other hand, if the day is very hot and the air is moist the evaporation of perspiration will be less rapid because the air is already loaded with moisture. This prevents the body from cooling itself by the process of evaporation. It thus appears that a moist air seems colder at 35° and warmer at 95° than dry air at the same temperatures. In either case an increase in the *movement* of the air would make it seem colder or cooler because moving air continually changes the aerial blanket and increases heat transfer and evaporation.

Odors.—We have said that disagreeable odors are injurious to health in having a definite effect upon the appetite. They

probably also irritate or depress the nervous system. To be sure the olfactory nerve soon becomes tired and insensible to a given odor but the depressing effect no doubt continues.

The nose can always detect a new odor or a different odor and for this reason the odor of the air is a good index of its freshness or staleness when one *first enters* the room. Odors arise from foul breath, an unclean mouth, decayed teeth, catarrh, the sudoriferous glands from the feet and axillæ, and from the decomposition of organic matter on the skin and clothes. Moisture is always necessary for the detection of odors and they therefore become more objectionable as the

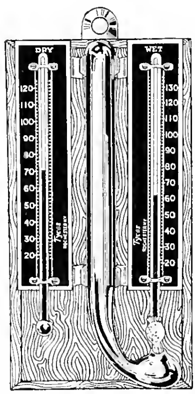

Fig. 49.—Wet and dry bulb thermometer for wall attachment. (Courtesy of the Taylor Instrument Companies, Rochester, N. Y.)

air becomes more humid. Sometimes heat or a draft of compressed air will remove odors from solid surfaces where mere ventilation will not.

Testing Air.—The air in living rooms which is not being changed with sufficient frequency is likely to be odorous and it is not difficult to detect this with the senses upon entering a close or stuffy room. The test for the amount of carbon dioxide in the air will also indicate whether the air is fresh or used. The temperature may be read directly from a thermometer.

But we must know the relative humidity of air as well as its temperature in order to know whether it is properly conditioned for the body. *Relative humidity* is expressed in terms of per cent saturation. When the air is completely saturated with moisture we have a mist or fog. At 68° F. the optimum humidity is about 50 per cent.

The body is sensitive to the dryness of the air because the drier the air the greater the evaporation of moisture. It is this principle that is used in determining relative humidity. If the bulb of an ordinary thermometer is wrapped in a moist cloth, evaporation will take place from the cloth and the thermometer will be cooled, registering a lower temperature

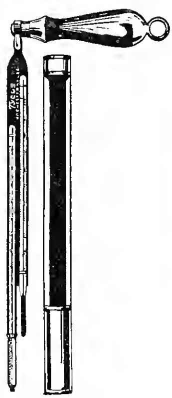

Fig. 50.—Sling psychrometer. (Courtesy of the Taylor Instrument Companies, Rochester, N. Y.)

than the ordinary thermometer in the same room. The drier the air, the greater the rate of evaporation, the greater will be the difference between the dry bulb and wet bulb readings. The movement of air also affects the rate of evaporation; but evaporation approaches its maximum rate when the air is moving at about four miles per hour, so that if the wet bulb thermometer is swung in the air with a free arm motion the minimum reading can be obtained in a few moments.

The Sling Psychrometer.—An instrument in common use for testing the dryness of air is the sling psychrometer which consists of a dry bulb thermometer and a wet bulb thermometer attached to a solid frame which can be rotated in the air. The instrument is swung until the minimum reading is obtained on the wet bulb thermometer and the relative humidity is obtained by comparing the difference in temperatures with a set of standard tables. From these tables it is possible to obtain the relative humidity, the number of grams of moisture in the air and the dew point for the air having its dry and wet bulb temperatures recorded.

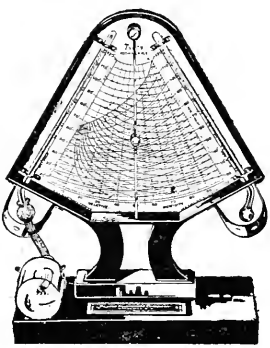

Fig. 51.—Hygrodeik showing the chart from which the condition of the air may be read directly. This is the most satisfactory instrument for telling moisture content quickly. (Courtesy of the Taylor Instrument Companies, Rochester, N. Y.)

The Hygrodeik.—This instrument has a dry and a wet bulb thermometer placed on the two sides of a graphic chart in such a way that the approximate percentage saturation, grains of water per cubic foot, and dew point may be read directly from the chart by comparing the temperatures of the two thermometers. A pointer swings across the chart between the thermometers and the desired readings may be obtained by placing it over the intersection of the two lines which connect the thermometer readings.

The Polymeter.—Various instruments are made which indicate roughly the relative humidity by showing the effect of moisture in contracting or expanding some substance like horse hairs. The horse hair is usually run from the top of the instrument to a shaft connecting with a dial at the base. If these instruments are kept in proper condition the dial will roughly indicate the amount of moisture in the air, that is, with an accuracy of perhaps 1° to 5°. But in order that they remain in good condition they should be dipped in water every day or at least every few days.

The Comfort Meter.—Dr. Hill has developed a new instrument for indicating the quality of the air which does away with the difficulty of trying to combine the two factors of temperature and humidity. This is a spirit thermometer graduated from 95° to 100° F. It is heated to 100° and the time taken to fall to 95° is registered. Without moisture this thermometer records of the effect of the temperature and motion of the air; when a cloth saturated with water is wrapped around the bulb it also takes account of the effect of humidity. It will be seen that this instrument when moistened at 100° F. closely simulates the body, and the cooling effect of the air upon a moist warm body at any temperature can thus be readily determined. The instrument is calibrated and the constant factor is written upon the back. By dividing the time in seconds by the constant factor, one obtains the loss of heat per square centimeter per second in terms of milli-calories. The wet bulb should show not less than 18 milli-calories per second and the dry bulb not less than 6.

VENTILATING AND HEATING

The problem of ventilation is to supply clean air, free from bacteria and dust, at the proper temperature and with the suitable amount of moisture. To ventilate we must renew the air in a room but in order to secure air which is properly conditioned we must often heat or cool, and moisten or dry the air in addition.

Merely because we have assigned new causes for the disagreeable effects which have always been recognized as the result of poor air, we must not forget that these ill effects still persist. Properly conditioned air must always be supplied and in a suitable quantity and standards of air space in different kinds of workrooms are still useful, although we should remember that the rate of change of air is more important than the size of the workroom.

The standards set by a committee of the American Society of Heating and Ventilation in 1915, prescribe for a theatre, a floor space per person of 6 square feet, a cubic space of 90 cubic feet, and an air spply of 1,200 cubic feet per hour. In a workshop the floor space should be increased usually to 25 square feet, the cubic space to 250 cubic feet, and the hourly air supply to 1,500 cubic feet per person (the amount of air required for an ordinary gas burner). The air should be of a temperature between 60° and 72° F. The distribution should maintain the proper temperature without uncomfortable drafts or any draft lower than 60° F. For temperatures above 55° F. the most comfortable percentage humidity may be obtained from the formula $R = 316 - 4T$, where $T =$ the temperature of the room and $R =$ the corresponding relative humidity.

The air should be free from unpleasant odors and reasonably free from dust which of itself is more or less irritating and is usually germ laden. Mechanical exhaust systems are needed in many workrooms to keep the air free from dust, while air washing is necessary in some localities to secure a satisfactory supply.

Natural Ventilation.—Ventilation may be either natural or artificial. By natural ventilation we mean the replacing of air inside a building by the outside air which works its way of its own accord through the wall and through openings to the outside. Even solid walls allow for the passage of a good deal of air and much more enters through open windows, ventilating flues, or chimneys, cracks or crevices in the walls,

under doors and around windows. There are numerous mechanical appliances which furnish openings through walls or windows and assist in the interchanging of inside and outside air. Sometimes this exchange of air is assisted by aspirating or withdrawing the air from within by means of the natural draft of a flue or chimney augmented by a heater. The amount of leakage of air in a building depends on the ratio of the cubic contents of the building to the exposed surface, the tightness of doors, windows, etc., and the condition of the walls. In general it is assumed that the leakage amounts to one change of air per hour. That is, an amount of air equal to the cubical contents of a frame building will pass through the walls each hour and an equal volume of air must be heated to replace the loss. The air will oftentimes be changed two times per hour by spontaneous ventilation.

The size of the room as well as the number of people in the room influences the rate at which the air should be changed. The number of changes of air which take place under direct heating in buildings is given below.

NUMBER OF TIMES AIR CHANGES PER HOUR

Residences	Halls 3; sitting-rooms 2
Stores	First story 2 to 3; 2nd story 1½ to 2
Offices	First story 2 to 2½; 2nd story 1½ to 2
Churches and Halls	¾ to 2
Large rooms with small exposure	½ to 1

Artificial or Mechanical Ventilation.—For large buildings such as halls, churches, business establishments and factories, the change of air through natural processes is not sufficient and some mechanical system of ventilation is adopted. This may be one of three types: (1) the exhaust or *vacuum system* by which air is withdrawn from the room by means of suction fans, (2) the *plenum system* by which air is forced into the room by fans or (3) the *combined method* which forcibly brings air into the room and forcibly exhausts it, combining both of the above systems.

There are various ways of introducing and removing air from a room, but in general it may be said that in buildings of moderate size such as residences, office-buildings, school-rooms and factories, where the building is cut up into rooms not over fifty feet square, the intake ducts should be in the side walls near the top of the room from eight to ten feet above the floor and should discharge the air with a velocity not exceeding 6 feet per second so that the drafts will not be felt. Exit ducts should be in the side walls near the floor. By bringing the heated air in at the top of the room its velocity is gradually dissipated and by the time the incoming air has descended to the breathing level no draft should be felt. The opening of a register should be from 0.66 to 0.75 of the area of the opening in the duct into which the register fits.

In modern factories the air is heated to a temperature of from 90°-140° and is forced into the building by fans. This air after supplying wall losses by its loss in temperature is taken back to the fan at 60°-70° and is then drawn through the heater, heated again to the higher temperature and forced back into the factory. The air in the factory is thus put under a slight pressure and any leakage of air is outward, therefore a small amount of outside air must be constantly added before the air passes through the heater.

There are various ways of distributing the air sent in by the fans. The most common method is by ducts located from 8 to 18 feet above the floor. It is also done by means of hollow pilasters in the sides of the long distributing ducts which extend the entire length of the building. The velocity of the discharged air varies from 3 to 50 feet per second depending on the size of the room. Where there are numerous outlets and low velocities, the combined area of the air inlets should exceed the discharge area of the fan by 25 per cent.

The Importance of Moisture.—It may be demonstrated that the air in a room at 65° F. and 50-55% relative humidity, actually feels warmer than that of a room which is maintained

at 70-75° F. and 30% relative humidity. This is due to the fact that the sensation of heat or cold felt by the body, or the "sensible temperature" is not indicated by the temperature of the dry bulb thermometer, but more closely corresponds to the temperature indicated by the wet bulb thermometer. From this it is evident that a higher temperature is maintained in our buildings than would be required if arrangements were made for maintaining the proper relative humidity.

If a room feels cold at 68° F. it is because the humidity is too low. The amount of moisture a cubic foot of air will hold depends entirely upon the temperature. The lower the temperature of the air, the less moisture it is capable of holding. Air at 70° F. will, if saturated, hold 8 grains of moisture per cubic foot. Air at 0° F. will hold practically 0.48 grains per cubic foot at saturation. The average relative humidity during winter is about 70%; hence air at 0° F. and 70% relative humidity contains 0.34 grains of moisture per cubic foot. If this air is drawn from outdoors into a building and heated to 70° F. the absolute humidity or the weight of moisture per cubic foot will remain the same as before, but the relative humidity is now reduced to about 4%. Such air is drier than that of the most arid region.

Dry furnace air is therefore likely to cause excessive evaporation and give one a chilly feeling. For living rooms and offices the humidity may be increased by plants, or by porous dishes, like flower-pots, containing water or by placing a dish of water or a wet towel on or near the radiator. It is evident that fuel can be saved by maintaining air of a reasonably high humidity.

Air Washing and Humidifying.—Although the humidity may be secured by simple devices in small rooms, more intensive methods must be used for large buildings. The types of air-washers and humidifiers in ordinary use are the "moist sheet"; "film of water"; and the "spray or rain" types. These are all modifications of one another and in all the water is forced through small openings in pipes so that a

sheet of water is formed, through which the air must pass. The water is discharged through perforated pipes extending across the top of chambers, these pipes discharging against a deflector.

In the general method of washing and conditioning air it is first drawn through the washer by means of a fan. The water carried mechanically by the air is separated by means of eliminator plates; then the saturated air is heated by heater-coils to the desired temperature. By regulating the temperature of the saturated air entering the heater, the humidity of the heated air may be made any desired amount. By the use of by-passes under the heating coils, mixing dampers, thermostats, etc., it is possible to supply a constant volume of pure air to the rooms and to regulate the humidity of this air. Tempering coils are important where the incoming air is apt to go below 32° F. especially where all the air handled is taken from out of doors.

The washing of air is often almost as important as the humidifying. It is necessary to use the outside air for ventilation and this air is taken from the lower levels where the amounts of dust, bacteria, and noxious gases are most concentrated. Whipple has shown that when street air is passed through a washer it requires but a few hours for the water to become like sewage in appearance and analysis. Air drawn from the rooms, purified and reheated is up to all standards and the cost of fuel necessary to heat the air is considerably reduced.

Cooling Air.—To cool air and at the same time to reduce the amount of moisture, it becomes necessary to work with water at a temperature lower than can ordinarily be obtained from either driven wells or from city mains. Air cooled by ice is unsatisfactory as it is difficult to cool it sufficiently to deposit the excess moisture and the slightly cooled air is likely to have a high relative humidity.

The only satisfactory method of air cooling is by the use of refrigerating machines, such as ammonia compression or absorption machines by which the temperature may be re-

duced enough to cause a precipitation of the excess of moisture contained in the air. When air is cooled by this method a fan draws the air from the room and sends it through a sheet of cold brine which is continually cooled by an ammonia outfit. This brine is sprayed into the air as is the water in an air washing machine.

In other cases the air may be sent through a cooler containing the coils of an ammonia machine. To keep the coils from becoming covered with frost, brine is allowed to trickle over them. This brine washes the air to some extent. It is very important that the brine be of sufficient strength to prevent freezing.

Air taken in from the room may be cooled, de-humidified and sent back or some of the outside air of higher temperature and humidity may be mixed with cooled air in proper proportion to give the final temperature and humidity desired. In general it is necessary to cool air to 45° or 50° in order to get rid of the excess moisture, and it is then necessary to heat this air again to 70°. The hot moist air on its way from the room to the cooler may be made to transfer some of its heat to the cold, de-humidified air on its way back to the room.

The Economic Value of Good Ventilation.—Industries have found that it is particularly important to remove dust, gases and fumes which irritate the breathing passages of the worker and cause congestion or predispose the individual to infectious diseases. But even where dusts are not present the proper regulation of temperature and humidity has an important bearing upon health and efficiency. Dr. Winslow has shown that under the same conditions of work 6 per cent more typewriting is performed at 68° than at 75°. In more vigorous physical work such as ordinary industrial activities, the amount accomplished at 68° is 15% greater than that accomplished at 75°. In the work of the New York Commission on Ventilation it was shown that the respiratory diseases among school children in a group of rooms averaging 69° in temperature were 50 per cent in excess of similar respiratory diseases among groups of children from school rooms whose tempera-

tures averaged only 66°. It is a cardinal rule that the temperature of living and work places should never exceed 68° and with proper humidity a healthy individual will not be uncomfortable at this temperature. Each work room should have a thermometer and some arrangement should occasionally be made to determine the humidity.

Physicians feel that out of door air is better than inside air for invalids and consumptives, even though the inside air is properly conditioned. This benefit from being out of doors may be due to sunlight or it may be due to the constantly varying temperature of the outdoor air which doubtless serves as a stimulus and tonic to the system.

LIGHTING

Good lighting is important in a variety of ways. Direct sunlight is a disinfectant and it has been found to increase the peripheral lymphocytosis in the body. Its value in treating tuberculosis of the skin, for example, has been well demonstrated. It should be allowed to enter the home and the work place as much as possible but it should be prevented from shining directly in the face of the worker.

Outdoor life is the normal condition to which man has become accustomed throughout the process of evolution. Under these conditions the light comes from a luminous body above and very little light is reflected from the green or brown of the earth, so that the upper part of the retina is not accustomed to a strong stimulation. If the person looks up at the sun directly the stimulation is excessive and painful. This suggests the ideal condition for artificial lighting. Strong light should not be thrown directly into the eyes from below.

Man has acquired great power in adjusting the eyes to the effects of bright daylight and darkness. This is done by varying the size of the pupil through the muscular contraction of the iris. Flickering light causes the eye to attempt a rapid series of these adjustments, a continual contraction and expansion of this muscle resulting in eye strain, nervousness and fatigue.

Ideal lighting provides sufficient and steady illumination at the point of work and the lighting should be judged not by the brightness of the lamps but by the illumination at the point where the work is done. Dark objects require more illumination than light objects.

Office Lighting.—Ample window space is usually provided in front of the dentist's chair but sufficient care is not always taken to provide adequate means of regulating the lighting under different weather conditions by means of shades and

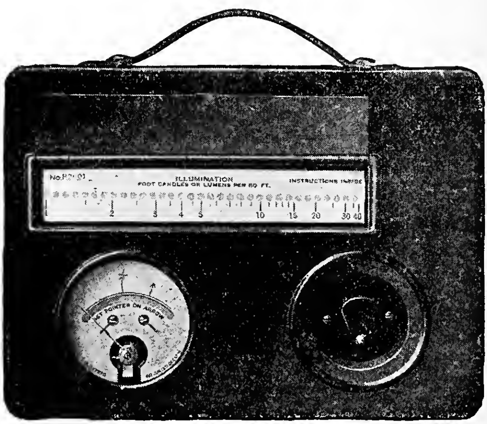

Fig. 52.—A foot candlemeter which is portable and easy to use in measuring light intensities. (Courtesy of the National Lamp Works, Cleveland, Ohio.)

curtains. These should be so arranged that they can be made to cover either the lower or the upper part of the windows and should be of light green or yellow material.

The artificial lighting should be indirect in order to avoid glare either in the eyes of the operator or the patient. Indirect lighting may be provided by the use of translucent material or by a reflector throwing the light up to the ceiling. Much light is lost by the latter type of lighting however and more efficiency can be secured by the use of a ridged glass which splits and divides the rays of light. In any case the artificial light should be steady and not flickering.

APPENDIX A

THE CONTROL OF COMMUNICABLE DISEASES

REPORT OF THE AMERICAN PUBLIC HEALTH ASSOCIATION COMMITTEE ON STANDARD REGULATIONS, APPOINTED IN OCTOBER, 1916.*

In the following report the terms used are first defined. Each disease is briefly described with regard to the infective agent, the source of infection, the mode of transmission, the incubation period, and the period of communicability. Following this are given the methods of control—first, those affecting the individual patient and his immediate environment, and second, general measures bearing upon the control or prevention of the disease in question.

Inasmuch as the laws under which various boards and departments of health operate require differences in the legal phraseology of rules, regulations, or sections of sanitary codes dealing with the control of communicable diseases the committee has refrained from preparing formal regulations under each disease. As the report is at present submitted any health officer, board of health, or legislative body having the power to make rules or regulations or pass sections of sanitary codes dealing with the control of communicable diseases can, by reference to the description of the disease and recommendations for methods of control herewith proposed, easily prepare the necessary text upon which the educational and administrative acts of the health officer will be based. The list of diseases considered by the committee and herewith reported upon includes those given in the *Public Health Reports*, Vol. 30, No. 27, July 2, 1915, of the Public Health Service in "A Model State Law for Morbidity Reports."

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*Reprint from the Public Health Reports, vol. 32, No. 41, Oct. 12, 1917, pp. 1706-1733. Used with permission of the American Public Health Assn.

The committee is indebted for expert opinion and critical comment upon its tentative conclusions to Dr. Simon Flexner, Dr. William H. Park, Prof. Theobald Smith, and Dr. Bertram H. Waters, and acknowledgment of their contributions to the report in its present form is herewith gratefully expressed.

DR. HAVEN EMERSON, CHAIRMAN.
ROBERT N. HOYT.
DR. F. M. MEADER.
DR. J. C. PERRY.
C. E. A. WINSLOW.

List of Diseases

Actinomycosis.
Acute infectious conjunctivitis.
Anchylostomiasis (hookworm).
Anthrax.
Cerebrospinal meningitis (epidemic).
Chicken pox.
Cholera.
Dengue.
Diphtheria.
Dysentery (amebic).
Dysentery (bacillary).
Favus.
German measles.
Glanders.
Gonorrhea.
Leprosy.
Malaria.
Measles.
Mumps.
Paratyphoid fever.
Plague.
Pneumonia (acute lobar).
Poliomyelitis.
Rabies.
Rocky Mountain spotted or tick fever.
Scarlet fever.
Septic sore throat.
Smallpox.
Syphilis.
Tetanus.
Trachoma.
Trichinosis.
Tuberculosis (pulmonary).
Tuberculosis (other than pulmonary).
Typhoid fever.
Typhus fever.
Whooping cough.
Yellow fever.

The committee adopted the following definitions of terms:

1. *Carrier.*—A person who, without symptoms of a communicable disease, harbors and disseminates the specific microorganisms.

2. *Cleaning.*—This term signifies the removal, by scrubbing and washing, of organic matter on which and in which bacteria may find favorable conditions for prolonging life and virulence; also the removal by the same means of bacteria adherent to surfaces.

3. *Contact.*—A "contact" is any person or animal known to have been sufficiently near to a human infected person or animal to have been exposed to transfer of infectious material directly, or by articles freshly soiled with such material.

4. *Delousing.*—By delousing is meant the process by which a person and his personal apparel are treated so that neither the adults nor the eggs of Pediculus corporis or Pediculus capitis survive.

5. *Disinfection.*—By this is meant the destroying of the vitality of pathogenic microorganisms by chemical or physical means.

When the word *concurrent* is used as qualifying disinfection, it indicates the application of disinfection immediately after the discharge from the body of an infected person, of infectious material, or the soiling of articles with such infectious discharges.

When the word *terminal* is used as qualifying disinfection, it indicates the process of rendering the personal clothing and immediate physical environment of the patient free from the possibility of conveying the infection to others, at the time when the patient is no longer a source of infection.

6. *Education in personal cleanliness.*—By this phrase it is intended to include all the various means available to impress upon all members of the community, young and old, and especially when communicable disease is prevalent or during epidemics, by spoken and printed word, and by illustration and suggestion, the necessity of:

(1) Washing the body daily with soap and water.

(2) Washing hands in soap and water after voiding bowels or bladder and always before eating.

(3) Keeping hands and unclean articles, or articles which have been used for toilet purposes by others away from mouth, nose, eyes, ears, and vagina.

(4) Avoiding the use of common or unclean eating, drinking, or toilet articles of any kind, such as towels, handkerchiefs, hair brushes, drinking cups, pipes, etc.

(5) Avoiding direct exposure to the spray from the noses and mouths of people who cough or sneeze, or laugh and talk loudly, with wide open mouth, or in explosive manner.

7. *Fumigation.**—By fumigation is meant a process by which the destruction of insects, as mosquitoes and body lice, and animals, as rats, is accomplished by the employment of gaseous agents.

**Author's Note:* This definition of fumigation applies throughout the following report and was doubtless arbitrarily adopted because fumigation is no longer regarded as effective for killing the germs of disease. Fumigation is still understood by the general public, however, as an attempt at disinfection by means of a gas.

8. *Isolation.**—By isolation is meant the separating of persons suffering from communicable disease, or carriers of the infecting organism, from other persons, in such places and under such conditions as will prevent the direct or indirect conveyance of the infectious agent to susceptible persons.

9. *Quarantine.**—By quarantine is meant the limitation of freedom of movement of persons or animals who have been exposed to communicable disease for a period of time equal to the incubation period of the disease to which they have been exposed.

10. *Renovation.*—By renovation is meant, in addition to cleansing, such treatment of the walls, floors, and ceilings of rooms or houses as may be necessary to place the premises in a satisfactory sanitary condition.

11. *Report of a disease.*—By report of a disease is meant the notification to the health authorities, and, in the case of communicable disease in animals, also to the respective departments of agriculture who have immediate jurisdiction, that a case of communicable disease exists in a specified person or animal at a given address.

12. *Susceptibles.*—A susceptible is a person or animal who is not known to have become immune to the particular communicable disease in question by natural or artificial process.

The items considered necessary for presentation by the committee with regard to each disease are the following:

1. Infective agent.
2. Source of infection.
3. Mode of transmission.
4. Incubation period.
5. Period of communicability.
6. Methods of control.
    (A) The infected individual and his environment:
        1. Recognition of the disease.
        2. Isolation.
        3. Immunization.
        4. Quarantine.
        5. Concurrent disinfection.
        6. Terminal disinfection.
    (B) General measures.
    (C) Epidemic measures (occasionally require separate mention).

*In view of the various ambiguous and inaccurate uses to which the words isolation and quarantine are not infrequently put, it has seemed best to adopt arbitrarily the word isolation as describing the limitation put upon the movements of the known sick or "carrier" individual or animal, and the word quarantine the limitations put upon exposed or "contact" individuals or persons.

Actinomycosis

1. *Infective agent*: Actinomyces bovis.
2. *Source of infection*: The nasal and bowel discharges, and the infected material from lesions in human and animal cases of the disease. Uncooked meat from infected animals may serve as a source of infection.
3. *Mode of transmission*: By contact with the discharges or with articles freshly soiled with the discharges from animal or human cases.
4. *Incubation period*: Unknown.
5. *Period of communicability*: As long as open lesions remain, as proved by the presence of the infective agent on microscopic or cultural tests.
6. *Methods of control*:
   (A) The infected individual and his environment—
   1. Recognition of the disease—Clinical symptoms, confirmed by microscopic examination of discharges from the lesions.
   2. Isolation—None, provided the patient is under adequate medical supervision.
   3. Immunization—None.
   4. Quarantine—None.
   5. Concurrent disinfection—Of discharges from lesions and articles soiled therewith.
   6. Terminal disinfection—By thorough cleaning.

   (B) General measures—
   1. Inspection of meat, with condemnation of carcasses, or infected parts of carcasses, of infected animals.
   2. Destruction of known animal sources of infection.

Acute Infectious Conjunctivitis

(Not including trachoma)

(This title to replace the terms gonorrheal ophthalmia, ophthalmia neonatorum, and babies' sore eyes.)

1. *Infectious agent*: The gonococcus or some member of a group of pyogenic organisms, including the hemoglobinophilic bacilli.
2. *Source of infection*: Discharges from conjunctivæ, or adnexa, or genital mucous membranes of infected persons.
3. *Modes of transmission*: Contact with an infected person or with articles freshly soiled with discharges of such person.

4. *Incubation period*: Irregular, but usually 36 to 48 hours.
5. *Period of communicability*: During the course of the disease and until the discharges from the infected mucous membranes have ceased.
6. *Methods of control*:
   (A) The infected individual and his environment—
   1. Recognition of the disease—Clinical symptoms, confirmed where possible by bacteriological examination.
   2. Isolation—None, provided the patient is under adequate medical supervision.
   3. Immunization—None.
   4. Quarantine—None.
   5. Concurrent disinfection—Disinfection of conjunctival discharges and articles soiled therewith.
   6. Terminal disinfection—Thorough cleansing.

   (B) General measures—
   1. Enforcement of regulations forbidding the use of common towels and toilet articles. Education as to personal cleanliness.
   2. Use of silver nitrate or some similar solution in the eyes of the new born.

Anchylostomiasis

(Hookworm)

1. *Infectious agent.*—Anchylostoma (Necator americanus).
2. *Source of infection.*—Feces of infested persons. Infection generally takes place through the skin, occasionally by the mouth.
3. *Mode of transmission.*—The larval forms pierce the skin, usually of the foot, and passing through the lymphatics to the vena cava and the right heart, thence in the blood stream to the lungs, they pierce the capillary walls and pass into the alveoli. Then they pass up the bronchi and trachea to the throat, whence they are swallowed and finally lodge in the small intestine. Also by drinking water containing larvæ, by eating soiled food, by hand to mouth transmission of the eggs or larvæ from objects soiled with infected discharges.
4. *Incubation period.*—Seven to 10 weeks.
5. *Period of communicability.*—As long as the parasite or its ova are found in the bowel discharges of an infected individual. Contaminated soil remains infective for five months in the absence of freezing.
6. *Methods of control*:
   (A) The infected individual and his environment—
   1. Recognition of the disease—Microscopic examination of bowel discharges.

2. Isolation—None.
3. Immunization—None.
4. Quarantine—None.
5. Concurrent disinfection—Sanitary disposal of bowel discharges.
6. Terminal disinfection—None.
7. Treatment—Appropriate treatment of infected individual to rid the intestinal canal of the parasite and its ova.

(B) General measures—
1. Education as to dangers of soil pollution.
2. Prevention of soil pollution by installation of sanitary disposal systems for human discharges.
3. Personal prophylaxis by cleanliness and the wearing of shoes.

Anthrax

1. *Infectious agent.*—Bacillus anthracis.
2. *Source of infection.*—Hair, hides, flesh, and feces of infected animals.
3 *Mode of transmission.*—Inoculation as by accidental wound or scratch, inhalation of spores of the infectious agent, and ingestion of insufficiently cooked infected meat.
4. *Incubation period.*—Within seven days.
5. *Period of communicability.*—During the febrile stage of the disease and until lesions have ceased discharging. Infected hair and hides of infected animals may communicate the disease for many months after slaughter of the animal, and after curing of hide, fur, or hair, unless disinfected.
6. *Methods of control*:

(A) The infected individual and his environment—
1. Recognition of the disease—Clinical symptoms, confirmed by bacteriological examination.
2. Isolation of the infected individual until the lesions have healed.
3. Immunization—None.
4. Quarantine—None.
5. Concurrent disinfection of the discharges from lesions and articles soiled therewith.
6. Terminal disinfection—Thorough cleaning.

(B) General measures—
1. Animals ill with a disease presumably anthrax should be placed immediately in the care of a veterinary surgeon. Proved animal cases of the disease should be killed promptly and the carcasses destroyed, preferably by fire.

2. Isolation of all animals affected with the disease.
3. Immunization of exposed animals under direction of Federal or State Department of Agriculture.
4. Postmortem examinations should be made only by a veterinary surgeon, or in the presence of one.
5. Milk from an infected animal should not be used during the febrile period.
6. Control and disinfection of effluents and trade wastes and of areas of land polluted by such effluents and wastes from factories or premises, where spore-infected hides or other infected hide and hair products are known to have been worked up into manufactured articles.
7. A physician should be constantly employed by every company handling raw rides, or such companies should operate under the direct supervision of a medical representative of the health department.
8. Every employee handling raw hides, hair, or bristles who has an abrasion of the skin should immediately report to a physician.
9. Special instruction should be given to all employees handling raw hides in regard to the necessity of personal cleanliness.
10. Tanneries and woolen mills should be provided with proper ventilating apparatus so that dust can be promptly removed.
11. Disinfection of hair, wool, and bristles of animals originating in known infected centers before they are used or assorted.
12. The sale of hides from an animal infected with anthrax should be prohibited. A violation of this regulation should be immediately reported to the State commissioner of agriculture, by telegram, stating the time, place, and purchaser to whom the hide was sold. The report should also be sent to the person purchasing the hide. Carcasses should be disposed of under the supervision of the State department of agriculture. The inspection and disinfection of imported hides are under the supervision of the United States Bureau of Animal Industry. In the event that infection is introduced the State agricultural authorities have jurisdiction over infected animals and the local or State health authorities have jurisdiction over infected persons.

Cerebrospinal Meningitis

1. *Infective agent*: Diplococcus intracellularis (the meningococcus).
2. *Source of infection*: Discharges from the nose and mouth of infected persons. Clinically recovered cases, and healthy persons who have never had the disease but have been in contact with cases of the disease or other carriers, act as carriers and are commonly found, especially during epidemics. Such healthy carriers are not uncommonly found independent of epidemic prevalence of the disease.
3. *Mode of transmission*: By direct contact with infected persons and carriers, and indirectly by contact with articles freshly soiled with the nasal and mouth discharges of such persons.
4. *Incubation period*: Two to ten days, commonly seven. Occasionally for longer periods when a person is a carrier for a time before developing the disease.
5. *Period of communicability*: During the clinical course of the disease and until the specific organism is no longer present in the nasal and mouth discharges of the patient. The same applies to healthy carriers so far as affects persistence of infectious discharges.
6. *Methods of control*:

    (A) The infected individual and his environment—

    1. Recognition of the disease—Clinical symptoms, confirmed by the microscopic and bacteriological examination of the spinal fluid, and by bacteriological examination of nasal and pharyngeal secretions.
    2. Isolation of infected persons and carriers until the nasopharynx is free from the infecting organism, or, at the earliest, until one week after the fever has subsided.
    3. Immunization may prove of value. Immunization by the use of vaccines still in the experimental stage.
    4. Quarantine—None.
    5. Concurrent disinfection of discharges from the nose and mouth and of articles soiled therewith.
    6. Terminal disinfection—Cleaning.

    (B) General measures—

    1. Search for carriers among families and associates of recognized cases by bacteriological examination of posterior nares of all contacts.
    2. Education as to personal cleanliness and necessity of avoiding contact and droplet infection.
    3. Prevention of overcrowding such as is common in living quarters, transportation conveyances, working places, and places of public assembly in the civilian population, and in inadequately ventilated closed quarters in barracks, camps, and ships among military units.

Chicken Pox

1. *Infectious agent:* Unknown.
2. *Source of infection:* The infectious agent is presumably present in the lesions of the skin and of the mucous membranes; the latter appearing early and rupturing as soon as they appear, render the disease communicable early, that is, before the exanthem is in evidence.
3. *Mode of transmission:* Directly from person to person; indirectly through articles freshly soiled by discharges from an infected individual.
4. *Incubation period:* Two to three weeks.
5. *Period of communicability:* Until the primary scabs have disappeared from the mucous membranes and the skin.
6. *Methods of control:*
   (A) The infected individual and his environment—
   1. Recognition of the disease—Clinical symptoms. The differential diagnosis of this disease from smallpox is important, especially in people over 15 years of age.
   2. Isolation—Exclusion of patient from school, and prevention of contact with nonimmune persons.
   3. Immunization—None.
   4. Quarantine—None.
   5. Concurrent disinfection of articles soiled by discharges from lesions.
   6. Terminal disinfection—Thorough cleaning.

   (B) General measures—None.

Cholera

1. *Infectious agent:* Vibrio choleræ.
2. *Source of infection:* Bowel discharges and vomitus of infected persons, and feces of convalescent or healthy carriers. Ten per cent of contacts may be found to be carriers.
3. *Mode of transmission:* By food and water polluted by infectious agent; by contact with infected persons, carriers, or articles freshly soiled by their discharges; by flies.
4. *Incubation period:* One to five, usually three, days, occasionally longer if the healthy carrier stage, before development of symptoms, is included.
5. *Period of communicability:* Usually 7 to 14 days or longer and until the infectious organism is absent from the bowel discharges.
6. *Methods of control:*
   (A) The infected individual and his environment—
   1. Recognition of the disease—Clinical symptoms, confirmed by bacteriological examination.

2. Isolation of patient in hospital or screened room.
3. Immunization by vaccination may be of value.
4. Quarantine—Contacts for five days from last exposure, or longer if stools are found to contain the cholera vibrio.
5. Concurrent disinfection—Prompt and thorough disinfection of the stools and vomited matter. Articles used by and in connection with the patient must be disinfected before removal from the room. Food left by the patient should be burned.
6. Terminal disinfection—Bodies of those dying from cholera should be cremated if practicable, or, otherwise, wrapped in a sheet wet with disinfectant solution and placed in water-tight caskets. The room in which a sick patient was isolated should be thoroughly cleaned and disinfected.

(B) General measures—

1. Rigid personal prophylaxis of attendants by scrupulous cleanliness, disinfection of hands each time after handling patient or touching articles contaminated by dejecta, the avoidance of eating or drinking anything in the room of the patient, and the prohibition of those attendant on the sick from entering the kitchen.
2. The bacteriological examination of the stools of all contacts to determine carriers. Isolation of carriers.
3. Water should be boiled, if used for drinking or toilet purposes, or if used in washing dishes or food containers, unless the water supply is adequately protected against contamination or is so treated, as by chlorination, that the cholera vibrio can not survive in it.
4. Careful supervision of food and drink. Where cholera is prevalent, only cooked foods should be used. Food and drink after cooking or boiling should be protected against contamination, as by flies and human handling.

(C) Epidemic measures—

Inspection service for early detection and isolation of cases; examination of persons exposed in infected centers for detection of carriers, with isolation or control of carriers; disinfection of rooms occupied by the sick, and the detention, in suitable camps for five days, of those desirous of leaving for another locality. Those so detained should be examined for detection of carriers.

Dengue

1. *Infectious agent*: Unknown.
2. *Source of infection*: The blood of infected persons.
3. *Mode of transmission*: By the bite of infected mosquitoes, probably Aedes calopus (perhaps also Culex fatigans).
4. *Incubation period*: Four to five days.
5. *Period of communicability*: During the febrile stage of the disease.
6. *Methods of control*:

   (A) The infected individual and his environment—

   1. Recognition of the disease—Clinical symptoms.
   2. Isolation—The patient must be kept in a screened room.
   3. Immunization—None.
   4. Quarantine—None.
   5. Concurrent disinfection—None.
   6. Terminal disinfection—None. Upon termination of the case, fumigation of the room and house, to destroy mosquitoes.

   (B) General measures—

   Measures directed toward elimination of mosquitoes. Screening of rooms.

Diphtheria

1. *Infectious agent*: Bacillus diphtheriæ (the Klebs-Loeffler bacillus).
2. *Source of infection*: Discharges from diphtheritic lesions of nose, throat, conjunctiva, vagina, and wound surfaces. Secretions from the nose and throat of carriers of the bacillus.
3. *Mode of transmission*: Directly by personal contact, indirectly by articles freshly soiled with discharges, or through infected milk or milk products.
4. *Incubation period*: Usually two to five days, occasionally longer if a healthy carrier stage precedes the development of clinical symptoms.
5. *Period of communicability*: Until virulent bacilli have disappeared from the secretions and the lesions. The persistence of the bacilli after the lesions have healed is variable. In fully three-quarters of the cases they disappear within two weeks. In 95 per cent of cases, the bacilli disappear in four weeks. In exceptional cases virulent bacilli remain in the throat and discharges for from two to six months.
6. *Methods of control*:

   (A) The infected individual and his environment—

   1. Recognition of the disease—By clinical symptoms with confirmation by bacteriological examination of discharges.

2. Isolation—Until two cultures from the throat and two from the nose, taken not less than 24 hours apart, fail to show the presence of diphtheria bacilli. Isolation may be terminated if persistent diphtheria bacilli prove avirulent. Where termination by culture is impracticable cases may be terminated with fair safety as a rule 16 days after onset of the disease.
3. Immunization—Exposed susceptibles to be promptly immunized by antitoxin. (By susceptibles is meant such individuals as are found to be nonimmune by the Schick test, i. e., those who give a positive reaction).
4. Quarantine—All exposed persons until shown by bacteriological examination not to be carriers.
5. Concurrent disinfection of all articles which have been in contact with the patient and all articles soiled by discharges from the patient.
6. Terminal disinfection—At the end of the illness, thorough airing and sunning of the sick room, with cleaning or renovation.

(B) General measures—
1. Pasteurization of milk supply.
2. Application of the Schick test to all contacts, and immunization of all susceptibles.
3. Application of the Schick test to all children.
4. Immunization by toxin-antitoxin inoculation of all susceptibles.
5. Determination of presence or absence of carriers among contacts, and, so far as practicable, in the community at large.

Dysentery (Amebic)

1. *Infectious agent*: Ameba histolytica.
2. *Source of infection*: The bowel discharges of infected persons.
3. *Mode of transmission*: By drinking contaminated water, and by eating infected foods, and by hand to mouth transfer of infected material; from objects soiled with discharges of an infected individual or of a carrier; by flies.
4. *Incubation period*: Unknown.
5. *Period of communicability*: During course of disease and until repeated microscopic examination of stools shows absence of Ameba histolytica.

6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms, confirmed by microscopic examination of stools.
      2. Isolation—None.
      3. Immunization—None.
      4. Quarantine—None.
      5. Concurrent disinfection of the bowel discharges.
      6. Terminal disinfection—Cleaning.
   (B) General measures—
      1. Boil drinking water unless the supply is known to be free from contamination.
      2. Water supply should be protected against contamination and supervision should be exercised over all foods eaten raw.

Dysentery (Bacillary)

1. *Infectious agent*: Bacillus dysenteriæ.
2. *Source of infection*: The bowel discharges of infected persons.
3. *Mode of transmission*: By drinking contaminated water, and by eating infected foods, and by hand-to-mouth transfer of infected material; from objects soiled with discharges of an infected individual or of a carrier by flies.
4. *Incubation period*: Two to seven days.
5. *Period of communicability*: During the febrile period of the disease and until the organism is absent from the bowel discharges.
6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms, confirmed by serological and bacteriological tests.
      2. Isolation—Infected individuals during the communicable period of the disease.
      3. Immunization—Vaccines give considerable immunity. Owing to severe reactions their use is not universal, nor should it be made compulsory except under extreme emergency.
      4. Quarantine—None.
      5. Concurrent disinfection—Bowel discharges.
      6. Terminal disinfection—Cleaning.
   (B) General measures—
      1. Rigid personal prophylaxis of attendants upon infected persons.

2. No milk or food for human consumption should be sold from a place occupied by a patient unless the persons engaged therein occupy quarters separate from the house where the patient is sick, and all utensils used are cleaned and kept in a separate building, and under a permit from the health officer.
3. All attendants upon persons affected with this disease should be prohibited from having anything to do with the handling of food.
4. Necessary precautions against flies.

Favus

1. *Infectious agent*: Achorion schoenleinii.
2. *Source of infection*: Lesions of skin, particularly on scalp.
3. *Mode of transmission*: Direct contact with patient, and indirectly through toilet articles.
4. *Incubation period*: Unknown.
5. *Period of communicability*: Until skin and scalp lesions are all healed.
6. *Methods of control*:
   - (A) The infected individual and his environment—
     1. Recognition of the disease—Clinical symptoms confirmed by microscopic examination of crusts.
     2. Isolation—Exclusion of patient from school and other public places until lesions are healed.
     3. Immunization—None.
     4. Quarantine—None.
     5. Concurrent disinfection—Toilet articles of patient.
     6. Terminal disinfection—None.
   - (B) General measures—
     1. Elimination of common utensils, such as hair brushes and combs.
     2. Provision for adequate and intensive treatment and cure of cases of favus at hospitals and dispensaries, to abbreviate the period of infectivity of the patients.

German Measles

1. *Infectious agent*: Unknown.
2. *Source of infection*: Secretions of the mouth and possibly of the nose.
3. *Mode of transmission*: By direct contact with the patient or with articles freshly soiled with the discharges from the nose or throat of the patient.
4. *Incubation period*: From 10 to 21 days.

5. *Period of communicability*: Eight days from onset of the disease.
6. *Method of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms.
      2. Isolation—Separation of the patient from nonimmune children, and exclusion of the patient from school and public places for the period of presumed infectivity.
      3. Immunization—None.
      4. Quarantine—None except exclusion of nonimmune children from school and public gatherings, from the eleventh to the twenty-second day from date of exposure to a recognized case.
      5. Concurrent disinfection—Discharges from the nose and throat of the patient and articles soiled by discharges.
      6. Terminal disinfection—Airing and cleaning.
   (B) General measures—
      None.

NOTE.—The reason for attempting to control this disease is that it may be confused with scarlet fever during its early stages; each person having symptoms of the disease should therefore be placed under the care of a physician and the case should be reported to the local department of health.

Glanders

1. *Infectious agent*: Bacillus mallei.
2. *Source of infection*: Discharges from open lesions of mucous membranes, or of the skin of human or equine cases of the disease (i. e., pus and mucus from the nose, throat, and bowel discharges from infected man and horse).
3. *Mode of transmission*: Contact with a case or with articles freshly soiled by discharges from a human or equine case.
4. *Incubation period*: Unknown.
5. *Period of communicability*: Until bacilli disappear from discharges or until lesions have healed.
6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—By specific biological reactions, such as the complement fixation test, the mallein test, the agglutination test, or by nonspecific reactions, such as the Straus reaction, if confirmed by culture, or by identification of the Bacillus mallei, or by autopsy of doubtful cases.
      2. Isolation—Human case at home or hospital; for infected horses destruction rather than isolation is advised.

3. Immunization—None of established value or generally accepted.
4. Quarantine of all horses in an infected stable until all have been tested by specific reaction, and the removal of infected horses and terminal disinfection of stable have been accomplished.
5. Concurrent disinfection—Discharges from human cases and articles soiled therewith.
6. Terminal disinfection—Stables and contents where infected horses are found.

(B) General measures—
1. The abolition of the common drinking trough for horses.
2. Sanitary supervision of stables and blacksmith shops.
3. Semi-annual testing of all horses by a specific reaction where the disease is common.
4. Testing of all horses offered for sale where the disease is common.

Note.—In this disease, as in all infectious or communicable diseases from which both animals and humans suffer, cases occurring in animals should be reported to the Department of Agriculture and human cases should be reported to the Department of Health, reciprocal notification thereafter to be accomplished through official interdepartment channels.

Gonorrhea

1. *Infectious agent*: Gonococcus.
2. *Source of infection*: Discharges from lesions of inflamed mucous membranes and glands of infected persons, viz., urethral, vaginal, cervical, conjunctival mucous membranes, and Bartholin's or Skene's glands in the female, and Cowper's and the prostate glands in the male.
3. *Mode of transmission*: By direct personal contact with infected persons, and indirectly by contact with articles freshly soiled with the discharges of such persons.
4. *Incubation period*: One to eight days, usually three to five days.
5. *Period of communicability*: As long as the gonococcus persists in any of the discharges, whether the infection be an old or a recent one.
6. *Methods of control*:

(A) The infected individual and his environment—
1. Recognition of the disease—Clinical symptoms, confirmed by bacteriological examination or serum reaction.
2. Isolation—When the lesions are in the genitourinary tract, exclusion from sexual contact, and when the lesions are conjunctival, exclusion from school or contact with children, so long as the discharges contain the infecting organism.

3. Immunization—None.
4. Quarantine—None.
5. Concurrent disinfection—Discharges from lesions and articles soiled therewith.
6. Terminal disinfection—None.

(B) General measures—

1. Education in matters of sexual hygiene, particularly as to the fact that continence in both sexes at all ages is compatible with health and development.
2. Provision for accurate and early diagnosis, and treatment in hospitals and dispensaries of infected persons with consideration for privacy of record and provision for following cases until cured.
3. Repression of prostitution by use of police power and control of use of living premises.
4. Restriction of sale of alcoholic beverages.
5. Restrictions of advertising of services or medicines for the treatment of sex diseases, etc.
6. Elimination of common towels and toilet articles from public places.
7. Use of prophylactic silver solution in the eyes of the new born.
8. Exclusion of persons in the communicable stage of the disease from participation in the preparing and serving of food.
9. Personal prophylaxis should be advised to those who expose themselves to opportunity for infection.

Leprosy

1. *Infectious agent*: Bacillus leprae.
2. *Source of infection*: Discharges from lesions.
3. *Mode of transmission*: By close, intimate, and prolonged contact with infected individuals. Flies and other insects may be mechanical carriers.
4. *Incubation period*: Prolonged, undetermined.
5. *Period of communicability*: Infectivity exists throughout the duration of the disease. Where good standards of personal hygiene prevail this disease is but slightly communicable.
6. *Methods of control*:

(A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms, confirmed by bacteriological examination.

2. Isolation for life in national leprosarium when this is possible.
3. Immunization—None.
4. Quarantine—None.
5. Concurrent disinfection—Discharges and articles soiled with discharges.
6. Terminal disinfection—Thorough cleansing of living premises of the patient.

(B) General measures—
1. Lack of information as to the determining factors in the spread and communication of the disease makes any but general advice in matters of personal hygiene of no value.
2. As a temporary expedient, lepers may be properly cared for in local hospitals, or if conditions of the patient and his environment warrant, he may be allowed to remain on his own premises under suitable regulations.

Malaria

1. *Infectious agent*: The several species of malarial organisms.
2. *Source of infection*: The blood of an infected individual.
3. *Mode of transmission*: By bite of the infected Anopheles mosquitoes. The mosquito is infected by biting an individual suffering from acute or chronic malaria. The parasite develops in the body of the mosquito for from 10 to 14 days, after which time the sporozoites appear in its salivary glands.
4. *Incubation period*: Varies with the type of species of infecting organism and the amount of infection; usually 14 days in the tertian variety.
5. *Period of communicability*: As long as the malaria organism exists in the blood.
6. *Methods of control*:

(A) The infected individual and his environment—
1. Recognition of the disease—Clinical symptoms, always to be confirmed by microscopical examination of the blood. Repeated examinations may be necessary.
2. Isolation—Exclusion of patient from approach of mosquitoes, until his blood is rendered free from malarial parasites by thorough treatment with quinine.
3. Immunization—None. The administration of prophylactic doses of quinine should be insisted upon for those constantly exposed to infection and unable to protect themselves against Anopheles mosquitoes.

4. Quarantine—None.
5. Concurrent disinfection—None. Destruction of Anopheles mosquitoes in the sick room.
6. Terminal disinfection—None. Destruction of Anopheles mosquitoes in sick room.

(B) General Measures—

1. Employment of known measures for destroying larvæ of anophelines and the eradication of breeding places of such mosquitoes.
2. Blood examination of persons living in infected centers to determine the incidence of infection.
3. Screening sleeping and living quarters; use of mosquito nets.
4. Killing mosquitoes in living quarters.

Measles

1. *Infectious agent.*—A filterable virus.
2. *Source of infection.*—Buccal and nasal secretions of an infected individual.
3. *Mode of transmission.*—Directly from person to person; indirectly through articles freshly soiled with the buccal and nasal discharges of an infected individual. The most easily transmitted of all communicable diseases.
4. *Incubation period.*—Seven to eighteen days; usually 14 days.
5. *Period of communicability.*—During the period of catarrhal symptoms and until the cessation of abnormal mucous membrane secretions—minimum period of seven days from two days before to five days after the appearance of the rash.
6. *Methods of control:*

(A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms. Special attention to rise of temperature, Koplik spots and catarrhal symptoms in exposed individuals.
2. Isolation—During period of communicability.
3. Immunization—None.
4. Quarantine—Exclusion of exposed susceptible school children and teachers from school until 14 days from last exposure. This applies to exposure in the household. Exclusion of exposed susceptible children from all public gatherings for the same period.
5. Concurrent disinfection—All articles soiled with the secretions of the nose and throat.
6. Terminal disinfection—Thorough cleaning.

(B) General measures—

1. Daily examination of exposed children and of other possibly exposed persons. This examination should include record of the body temperature. A nonimmune exposed individual exhibiting a rise of temperature of 0.5°C. or more should be promptly isolated pending diagnosis.
2. Schools should not be closed or classes discontinued where daily observation of the children by a physician or nurse is provided for.
3. Education as to special danger of exposing young children to those exhibiting acute catarrhal symptoms of any kind.

Mumps

1. *Infective organism.*—Unknown.
2. *Source of infection.*—Secretions of the mouth and possibly of the nose.
3. *Mode of transmission.*—By direct contact with an infected person or with articles freshly soiled with the discharges from the nose or throat of such infected person.
4. *Incubation period.*—From 4 to 25 days. The most common period, 18 days, accepted as usual. A period of 21 days is not uncommon.
5. *Period of communicability.*—Unknown, but assumed to persist until the parotid gland has returned to its normal size.
6. *Methods of control:*

(A) The infected individual and his environment—

1. Recognition of the disease—Inflammation of Steno's duct may be of assistance in recognizing the early stage of the disease. The diagnosis is usually made on swelling of the parotid gland.
2. Isolation—Separation of the patient from nonimmune children and exclusion of the patient from school and public places for the period of presumed infectivity. (See 5).
3. Immunization—None.
4. Quarantine—Limited to exclusion of nonimmune children from school and public gatherings for 21 days after last exposure to a recognized case.
5. Concurrent disinfection—All articles soiled with the discharges from the nose and throat of the patient.
6. Terminal disinfection—None.

(B) General measures—

None.

Paratyphoid Fever

1. *Infectious agent*: Bacillus paratyphosus A or B.
2. *Source of infection*: Bowel discharges and urine of infected persons, and foods contaminated with such discharges of infected persons or of healthy carriers. Healthy carriers may be numerous in an outbreak.
3. *Mode of transmission*: Directly by personal contact; indirectly by contact with articles freshly soiled with the discharges of infected persons or through milk, water, or food contaminated by such discharges.
4. *Incubation period*: Four to ten days; average, seven days.
5. *Period of communicability*: From the appearance of prodromal symptoms, throughout the illness and relapses, during convalescence, and until repeated bacteriological examination of discharges show absence of the infecting organism.
6. *Methods of Control*:

   (A) The infected individual and his environment—

   1. Recognition of the disease—Clinical symptoms, confirmed by specific agglutination test, and by bacteriological examination of blood, bowel discharges or urine.
   2. Isolation—In fly-proof room, preferably under hospital conditions, of such cases as can not command adequate sanitary environment and nursing care in their homes.
   3. Immunization of exposed susceptibles.
   4. Quarantine—None.
   5. Concurrent disinfection—Disinfection of all bowel and urinary discharges and articles soiled with them.
   6. Terminal disinfection—Cleaning.

   (B) General measures—

   1. Purification of public water supplies.
   2. Pasteurization of public milk supplies.
   3. Supervision of other food supplies and of food handlers.*
   4. Prevention of fly breeding.
   5. Sanitary disposal of human excreta.
   6. Extension of immunization by vaccination as far as practicable.
   7. Supervision of paratyphoid carriers and their exclusion from the handling of foods.
   8. Systematic examination of fecal specimens, from those who have been in contact with recognized cases, to detect carriers.

*The human disease paratyphoid fever should not be confused with cases of food poisoning, or infection due to enteritidis bacilli of animal origin.

9. Exclusion of suspected milk supplies pending discovery of the person or other cause of contamination of the milk.
10. Exclusion of water supply, if contaminated, until adequately treated with hypochlorite or other efficient disinfectant, or unless all water used for toilet, cooking, and drinking purposes is boiled before use.

Plague

(Bubonic, Septicemic, Pneumonic)

1. *Infectious agent.*—Bacillus pestis.
2. *Source of infection.*—Blood of infected persons and animals, and sputum of human cases of plague pneumonia.
3. *Mode of transmission.*—Direct, in the pneumonic form. In other forms the disease is generally transmitted by the bites of fleas (Loemopsylla cheopis and Ceratophyllus fasciatus), by which the disease is carried from rats to man, also by fleas from other rodents. Accidental, by inoculation, or by the bites of infected animals. Bedbugs may transmit the infection; flies may possibly convey the infection.
4. *Incubation period.*—Commonly from 3 to 7 days, although occasionally prolonged to 8 or even 14 days.
5. *Period of communicability.*—Until convalescence is well established, period undetermined.
6. *Methods of control*:

   (A) The infected individual and his environment—

   1. Recognition of the disease—Clinical symptoms, confirmed by bacteriological examination of blood, pus from glandular lesions, or sputum.
   2. Isolation—Patient in hospital if practicable; if not, in a screened room which is free from vermin.*
   3. Immunization—Passive immunization of known exposed contacts; active immunization of those who may be exposed.
   4. Quarantine—Contacts for seven days.
   5. Concurrent disinfection—All discharges and articles freshly soiled therewith.
   6. Terminal disinfection—Thorough cleaning followed by thorough disinfection.

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*In plague pneumonia, personal prophylaxis, to avoid droplet infection, must be carried out by persons who come in contact with the sick. Masks or veils of cheese cloth should be worn as protective measures.

(B) General measures—

1. Extermination of rats and vermin by use of known methods for their destruction; destruction of rats on ships arriving from infected ports; examination of rats, ground squirrels, etc., in areas where the infection persists, for evidence of endemic or epidemic prevalence of the disease among them.
2. Supervision of autopsies of all deaths during epidemics.
3. Supervision of the disposal of the dead during epidemics, whether by burial, transfer, or holding in vault, whatever the cause of death.
4. Cremation, or burial in quick lime, of those dying of this disease.

Poliomyelitis

1. *Infectious agent*: Not definitely determined. Believed to be a filterable virus.
2. *Source of infection*: Nose, throat, and bowel discharges of infected persons or articles recently soiled therewith. Healthy carriers are supposed to be common.
3. *Mode of transmission*: By direct contact with an infected person or with a carrier of the virus, or indirectly by contact with articles freshly soiled with the nose, throat, or bowel discharges of such persons.
4. *Incubation period*: From 3 to 10 days, commonly 6 days.
5. *Period of communicability*: Unknown; apparently not more than 21 days from the onset of disease, but may precede onset of clinical symptoms by several days.
6. *Methods of control*:

(A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms, assisted by chemical and microscopical examination of the spinal fluid.
2. Isolation of all recognized cases in screened rooms.
3. Immunization—None.
4. Quarantine of exposed children of the household and of adults of the household whose vocation brings them into contact with children, or who are food handlers, for 14 days from last exposure to a recognized case.
5. Concurrent disinfection—Nose, throat, and bowel discharges and articles soiled therewith.
6. Terminal disinfection—Cleaning.

(B) General measures during epidemics—

1. Search for and examination of all sick children should be made.
2. All children with fever should be isolated pending diagnosis.
3. Education in such technique of bedside nursing as will prevent the distribution of infectious discharges to others from cases isolated at home.

Rabies

1. *Infectious agent*: Unknown.
2. *Source of infection*: Saliva of infected animals, chiefly dogs.
3. *Mode of transmission*: Inoculation with saliva of infected animals through abrasion of skin or mucous membrane, almost always by bites or scratches.
4. *Incubation period*: Usually 2 to 6 weeks. May be prolonged to 6 months or even longer.
5. *Period of communicability*: For 15 days in the dog (not known in man) before the onset of clinical symptoms and throughout the clinical course of the disease.
6. *Methods of control*:

(A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms, confirmed by the presence of Negri bodies in the brain of an infected animal, or by animal inoculations with material from the brain of such infected animal.
2. Isolation—None if patient is under adequate medical supervision, and the immediate attendants are warned of possibility of inoculation by human virus.
3. Immunization—Preventive vaccination (Pasteur treatment) after exposure to infection by inoculation.
4. Quarantine—None.
5. Concurrent disinfection of saliva of patient and articles soiled therewith.
6. Terminal disinfection—Thorough cleaning.

(B) General measures—

1. Muzzling of dogs when on public streets, or in places to which the public has access.
2. Detention and examination of dogs suspected of having rabies.
3. Immediate antirabic treatment of people bitten by dogs or by other animals suspected or known to have rabies, unless the animal is proved not to be rabid by subsequent observation or by microscopic examination of the brain and cord.

Pneumonia

(Acute Lobar)

1. *Infectious agent.*—Various pathogenic bacteria commonly found in the nose, throat, and mouth, such as the pneumococcus, the baccillus of Friedlander, the influenza bacillus, etc.
2. *Source of infection.*—Discharges from the mouth and nose of apparently healthy carriers, as well as of recognized infected individuals, and articles freshly soiled with such discharges.
3. *Mode of transmission.*—By direct contact with an infected person, or with articles freshly soiled with the discharges from the nose or throat of, and possibly from infected dust of rooms occupied by, infected persons.
4. *Incubation period.*—Short, usually two to three days.
5. *Period of communicability.*—Unknown; presumably until the mouth and nasal discharges no longer carry the infectious agent in an abundant amount or in a virulent form.
6. *Methods of control*:

    (A) The infected individual and his environment—

    1. Recognition of the disease—Clinical symptoms. Specific infecting organisms may be determined by serological and bacteriological tests early in the course of the disease.
    2. Isolation—Patient during clinical course of the disease.
    3. Immunization—None; vaccines are worthy of further careful trial.
    4. Quarantine—None.
    5. Concurrent disinfection—Discharges from the nose and throat of the patient.
    6. Terminal disinfection—Thorough cleaning, airing, and sunning.

    (B) General measures—

    In institutions and camps, when practicable, people in large numbers should not be congregated closely within doors. The general resistance should be considered by good feeding, fresh air, temperance in the use of alcoholic beverages, and other hygienic measures.

NOTE.—The early reporting of pneumonia is highly desirable in view of its communicability and the possibility of effective treatment of certain types with curative sera.

Rocky Mountain Spotted or Tick Fever

1. *Infectious agent.*—Unknown.
2. *Source of infection.*—Blood of infected animals, and infected ticks (Dermacentor species).

3. *Mode of transmission.*—By bites of infected ticks.
4. *Incubation period.*—Three to ten days, usually seven days.
5. *Period of communicability.*—Has not been definitely determined, probably during the febrile stage of the disease.
6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—By clinical symptoms of the disease in areas where the disease is known to be endemic.
      2. Isolation—None, other than care exercised to protect patients from tick bites when in endemic areas.
      3. Immunization—None.
      4. Quarantine—None.
      5. Concurrent disinfection—None. All ticks on the patient should be destroyed.
      6. Terminal disinfection—None.
   (B) General measures—
      1. Personal prophylaxis of persons entering the infected zones during the season of ticks, by wearing tick-proof clothing, and careful daily search of the body for ticks which may have attached themselves.
      2. The destruction of ticks by clearing and burning vegetation on the land in infected zones.
      3. The destruction of ticks on domestic animals by dipping, and the pasturing of sheep on tick infested areas where the disease is prevalent, with the object of diminishing the number of ticks.
      4. The destruction of small mammalian hosts as ground squirrels, chipmunks, etc.

Scarlet Fever

1. *Infectious agent.*—Unknown.
2. *Source of infection.*—The belief at present is that the virus is contained in the secretions from the nose and throat, in the blood and in the lymph nodes, and that it is given off in the discharges from the mouth, the nose, the ears, and from brokendown glands of infected persons.
3. *Mode of transmission.*—Directly by personal contact with an infected person; indirectly by articles freshly soiled with discharges of an infected person, or through contaminated milk.
4. *Incubation period.*—Two to seven days, usually three or four days.
5. *Period of communicability.*—Four weeks from the onset of the disease, without regard to desquamation, and until all abnormal discharges have stopped and all open sores have healed.

6. *Methods of control.*—
   (A) The infected individual and his environment—
      1. Recognition of the disease—By clinical symptoms.
      2. Isolation—In home or hospital, maintained in each case until the end of the period of infectivity.
      3. Immunization—None.
      4. Quarantine—Exclusion of exposed susceptible children and teachers from school, and food handlers from their work, until seven days have elapsed since last exposure to a recognized case.
      5. Concurrent disinfection—Of all articles which have been in contact with a patient and all articles soiled with discharges of the patient.
      6. Terminal disinfection—Thorough cleaning.
   (B) General measures—
      1. Daily examination of exposed children and of other possibly exposed persons for a week after last exposure.
      2. Schools should not be closed where daily observation of the children by a physician or nurse can be provided for.
      3. Education as to special danger of exposing young children to those exhibiting acute catarrhal symptoms of any kind.
      4. Pasteurization of milk supply.

Septic Sore Throat

1. *Infectious agent.*—Streptococcus (hemolytic type).
2. *Source of infection.*—The human naso-pharynx, usually the tonsils, any case of acute streptococcus inflammation of these structures being a potential source of infection, including the period of convalescence of such cases. The udder of a cow infected by the milker is an occasional source of infection. In such udders the physical signs of mastitis are usually absent.*
3. *Mode of transmission.*—Direct or indirect human contact; consumption of raw milk from an infected udder.
4. *Incubation period.*—One to three days.
5. *Period of communicability.*—In man, presumably during the continuance of clinical symptoms; in the cow, during the continuance of discharge of the streptococci in the milk, the condition in the udder tending to a spontaneous subsidence. The carrier stage may follow convalescence and persist for some time.

*Mastitis in the cow, due to bovine streptococci, is not a cause of septic sore throat in humans unless a secondary infection of the udder by a human type of streptococcus takes place.

6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms. Bacteriological examination of the lesions or discharges from the tonsils and naso-pharynx may be useful.
      2. Isolation—During the clinical course of the disease and convalescence, and particularly exclusion of the patient from participation in the production or handling of milk or milk products.
      3. Immunization—None.
      4. Quarantine—None.
      5. Concurrent disinfection—Articles soiled with discharges from the nose and throat of the patient.
      6. Terminal disinfection—Cleaning.
   (B) General measures—
      1. Exclusion of suspected milk supply from public sale or use, until pasteurized. The exclusion of the milk of an infected cow or cows in small herds is possible when based on bacteriological examination of the milk of each cow, and preferably the milk from each quarter of the udder at frequent intervals.
      2. Pasteurization of all milk.
      3. Education in the principles of personal hygiene and avoidance of the use of common towel, drinking and eating utensils.

Smallpox

1. *Infectious agent.*—Unknown.
2. *Source of infection.*—Lesions of the skin and mucous membranes of infected persons.
3. *Mode of transmission.*—By direct personal contact; by articles soiled with discharges from lesions. The virus may be present in all body discharges, including feces and urine. It may be carried by flies.
4. *Incubation period.*—Twelve to fourteen days. (Cases with incubation period of 21 days are reported.)
5. *Period of communicability.*—From first symptoms to disappearance of all scabs and crusts.
6 *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms. Tests for immunity may prove useful.
      2. Isolation—Hospital isolation in screened wards, free from vermin, until the period of infectivity is over.

3. Immunization—Vaccination.
4. Quarantine—Segregation of all exposed persons for 21 days from date of last exposure, or until protected by vaccination.
5. Concurrent disinfection of all discharges and articles soiled therewith.
6. Terminal disinfection—Thorough cleaning and disinfection of premises.

(B) General measures—

General vaccination in infancy, revaccination of children on entering school, and of entire population when the disease is prevalent.

NOTE.—Adjustment of the time of vaccination of infants to avoid teething or other mild and common indispositions, the time of vaccination of children of the runabout age and older with preference for the cool months of the year, and the manner of vaccination with preference for the single puncture or small area scratch method through the droplet of virus are important to observe in order to avoid possible complications or secondary and subsequent infections at the site of vaccination. Vaccination before the age of six months is particularly desirable.

Syphilis

1. *Infectious agent.*—Treponema pallidum.
2. *Source of infection.*—Discharges from the lesions of the skin and mucous membranes, and the blood of infected persons, and articles freshly soiled with such discharges or blood in which the Treponema pallidum is present.
3. *Mode of transmission.*—By direct personal contact with infected persons, and indirectly by contact with discharges from lesions or with the blood of such persons.
4. *Incubation period.*—About three weeks. (In rare instances reported to have been as long as 70 days.)
5. *Period of communicability.*—As long as the lesions are open upon the skin or mucous membranes and until the body is freed from the infecting organisms, as shown by microscopic examination of material from ulcers and by serum reactions.
6. *Methods of control:*

(A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms, confirmed by microscopical examination of discharges, and by serum reactions.
2. Isolation—Exclusion from sexual contact and from preparation or serving of food during the early and active period of the disease; otherwise none, unless the patient is unwilling to heed, or is incapable of observing, the precautions required by the medical adviser.

3. Immunization—None.
4. Quarantine—None.
5. Concurrent disinfection of discharges and of articles soiled therewith.
6. Terminal disinfection—None.

(B) General measures—

1. Education in matters of sexual hygiene, particularly as to the fact that continence in both sexes and at all ages is compatible with health and development.
2. Provision for accurate and early diagnosis and treatment, in hospitals and dispensaries, of infected persons, with consideration for privacy of record, and provision for following cases until cured.
3. Repression of prostitution by use of the police power and control of use of living premises.
4. Restriction of sale of alcoholic beverages.
5. Restriction of advertising of services or medicines for treatment of sex diseases, etc.
6. Abandonment of the use of common towels, cups, and toilet articles and eating utensils.
7. Exclusion of persons in the communicable stage of the disease from participation in the preparing and serving of food.
8. Personal prophylaxis should be advised to those who expose themselves to opportunity to infection.

Tetanus

1. *Infectious agent*: Bacillus tetani.
2. *Source of infection*: Animal manure, and soil fertilized with animal manure, and, rarely, the discharges from wounds.
3. *Mode of transmission*: Inoculation, or wound infection.
4. *Incubation period*: Six to fourteen days, usually nine.
5. *Period of communicability*: Patient not infectious except in rare instances where wound discharges are infectious.
6. *Methods of control*:

(A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms; may be confirmed bacteriologically.
2. Isolation—None.
3. Immunization—By antitoxin, single or repeated injection.
4. Quarantine—None.
5. Concurrent disinfection—None.
6. Terminal disinfection—None.

(B) General measures—

1. Supervision of the practice of obstetrics.
2. Educational propaganda such as "safety-first" campaign, and "safe and sane Fourth of July" campaign.
3. Prophylactic use of tetanus antitoxin where wounds have been acquired in regions where the soil is known to be heavily contaminated, and in all cases where wounds are ragged or penetrating.
4. Removal of all foreign matter as early as possible from all wounds.
5. Supervision of biological products, especially vaccines and sera.

Trachoma

1. *Infectious agent*:* The chief, although not yet known to be the only, infectious agents are the hemoglobinophilic bacilli including the so-called Koch-Weeks bacillus.
2. *Source of infection*: Secretions and purulent discharges from the conjunctivae and adnexed mucous membranes of the infected persons.
3. *Mode of transmission*: By direct contact with infected persons and indirectly by contact with articles freshly soiled with the infective discharges of such persons.
4. *Incubation period*: Undetermined.
5. *Period of communicability*: During the persistence of lesions of the conjunctivæ and of the adnexed mucous membranes or of discharges from such lesions.
6. *Methods of control*:

(A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms. Bacteriological examination of the conjunctival secretions and lesions may be useful.
2. Isolation.—Exclusion of the patient from general school classes.
3. Immunization—None.
4. Quarantine—None.
5. Concurrent disinfection of discharges and articles soiled therewith.
6. Terminal disinfection—None.

(B) General measures—

1. Search for cases by examination of school children, of immigrants, and among the families and associates of recognized cases; in addition, search for acute secreting disease of conjunctivæ and adnexed mucous mem-

*It has not yet been proven that trachoma is due to one specific organism.

branes, both among school children and in their families, and treatment of such cases until cured.
2. Elimination of common towels and toilet articles from public places.
3. Education in the principles of personal cleanliness and the necessity of avoiding direct or indirect transference of body discharges.
4. Control of public dispensaries where communicable eye diseases are treated.

Trichinosis

1. *Infectious agent.*—Trichinella spiralis.
2. *Source of infection.*—Uncooked or insufficiently cooked meat of infected hogs.
3. *Mode of transmission.*—Consumption of undercooked infected pork products.
4. *Incubation period.*—Variable; usually about one week.
5. *Period of communicability.*—Disease is not transmitted by human host.
6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms, confirmed by microscopical examination of muscle tissue containing trichinæ.
      2. Isolation—None.
      3. Immunization—None.
      4. Quarantine—None.
      5. Concurrent disinfection—Sanitary disposal of the feces of the patient.
      6. Terminal disinfection—None.
   (B) General measures—
      1. Inspection of pork products for the detection of trichinosis.
      2. Thorough cooking of all pork products at a temperature of 160°F. or over.

Tuberculosis (Pulmonary)

1. *Infectious agent.*—Bacillus tuberculosis (human). (In rare instances the bovine tubercle bacillus has been proved to be the cause of a pulmonary tuberculosis.)
2. *Source of infection.*—The specific organism present in the discharges, or articles freshly soiled with the discharges from any open tubercu-

lous lesions, the most important discharge being sputum. Of less importance are discharges from the intestinal and genito-urinary tracts, or from lesions of the lymphatic glands, bone, and skin.

3. *Mode of transmission.*—Direct or indirect contact with an infected person by coughing, sneezing, or other droplet infection, kissing, common use of unsterilized food utensils, pipes, toys, drinking cups, etc., and possibly by contaminated flies and dust.
4. *Incubation period.*—Variable and dependent upon the type of the disease.
5. *Period of communicability.*—Exists as long as the specific organism is eliminated by the host. Commences when a lesion becomes an open one, i. e., discharging tubercle bacilli, and continues until it heals or death occurs.
6. *Methods of control*:

(A The infected individual and his environment—

1. Recognition of the disease—By clinical symptoms and by thorough physical examination, confirmed by bacteriological examination and by serological tests.
2. Isolation of such "open" cases as do not observe the precautions necessary to prevent the spread of the disease.
3. Immunization—None.
4. Quarantine—None.
5. Concurrent disinfection of sputum and articles soiled with it. Particular attention should be paid to prompt disposal or disinfection of sputum itself, of handkerchiefs, cloths, or paper soiled therewith, and of eating utensils used by the patient.
6. Terminal disinfection—Cleaning and renovation.

(B) General measures—

1. Education of the public in regard to the dangers of tuberculosis and the methods of control, with especial stress upon the danger of exposure and infection in early childhood.
2. Provision of dispensaries and visiting-nurse service for discovery of early cases and supervision of home cases.
3. Provision of hospitals for isolation of advanced cases, and sanatoria for the treatment of early cases.
4. Provision of open-air schools and preventoria for pre-tuberculous children.
5. Improvement of housing conditions, and the nutrition of the poor.
6. Ventilation, and elimination of dusts in industrial establishments and places of public assembly.

7. Improvement of habits of personal hygiene and betterment of general living conditions.
8. Separation of babies from tuberculous mothers at birth.

Tuberculosis (Other than Pulmonary)

1. *Infectious agent.*—Bacillus tuberculosis (human and bovine).
2. *Source of infection.*—Discharges from mouth, nose, bowels and genito-urinary tract of infected humans; articles freshly soiled with such discharges; milk from tuberculous cattle; rarely the discharging lesion of bones, joints, and lymph nodes.
3. *Mode of transmission.*—By direct contact with infected persons, by contaminated food, and possibly by contact with articles freshly soiled with the discharges of infected persons.
4. *Incubation period.*—Unknown.
5. *Period of communicability.*—Until lesions are healed.
6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms confirmed by bacteriological and serological examinations.
      2. Isolation.—None.
      3. Immunization.—None.
      4. Quarantine.—None.
      5. Concurrent disinfection.—Discharges and articles freshly soiled with them.
      6. Terminal disinfection.—Cleaning.

   (B) General measures—
      1. Pasteurization of milk and inspection of meats.
      2. Eradication of tuberculous cows from milch herds used in supplying raw milk.
      3. Patients with open lesions should be prohibited from handling foods which are consumed raw.

Typhoid Fever

1. *Infectious agent.*—Bacillus typhosus.
2. *Source of infection.*—Bowel discharges and urine of infected individuals. Healthy carriers are common.
3. *Mode of transmission.*—Conveyance of the specific organism by direct or indirect contact with a source of infection. Among indirect means of transmission are contaminated water, milk, and shellfish. Contaminated flies have been common means of transmission in epidemics.
4. *Incubation period.*—From 7 to 23 days, averaging 10 to 14 days.

5. *Period of communicability.*—From the appearance of prodromal symptoms, throughout the illness and relapses during convalescence, and until repeated bacteriological examinations of the discharges show persistent absence of the infecting organism.
6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms, confirmed by specific agglutination test and bacteriological examination of blood, bowel discharges, or urine.
      2. Isolation—In fly-proof room, preferably under hospital conditions, of such cases as can not command adequate sanitary environment and nursing care in their homes.
      3. Immunization—Of susceptibles who are known to have been exposed or are suspected of having been exposed.
      4. Quarantine—None.
      5. Concurrent disinfection—Disinfection of all bowel and urinary discharges and articles soiled with them.
      6. Terminal disinfection—Cleaning.

   (B) General measures—
      1. Purification of public water supplies.
      2. Pasteurization of public milk supplies.
      3. Supervision of other food supplies, and of food handlers.
      4. Prevention of fly breeding.
      5. Sanitary disposal of human excreta.
      6. Extension of immunization by vaccination as far as practicable.
      7. Supervision of typhoid carriers and their exclusion from the handling of foods.
      8. Systematic examination of fecal specimens from those who have been in contact with recognized cases, to detect carriers.
      9. Exclusion of suspected milk supplies pending discovery of the person or other cause of contamination of the milk.
      10. Exclusion of water supply, if contaminated, until adequately treated with hypochlorite or other efficient disinfectant, or unless all water used for toilet, cooking, and drinking purposes is boiled before use.

Typhus Fever

1. *Infectious agent*: Bacillus typhi-exanthematici is claimed to be the causative agent; not yet definitely determined.
2. *Source of infection*: The blood of infected individuals.

3. *Mode of transmission*: Infectious agent transmitted by lice. (Pediculus corporis, P. capitis.)
4. *Incubation period*: Five to twenty days, usually twelve days.
5. *Period of communicability*: Until 36 hours have elapsed after the temperature reaches normal.
6. *Methods of control*:
   (A) The infected individual and his environment—
      1. Recognition of the disease—Clinical symptoms. (Confirmation by bacteriological examination of blood claimed by Plotz.)
      2. Isolation—In a vermin-free room. All attendants should wear vermin-proof clothing.
      3. Immunization—Claimed to be practicable by use of vaccine (Plotz, Olitzky, and Baehr). Not yet generally accepted.
      4. Quarantine—Exposed susceptibles for 12 days after last exposure.
      5. Concurrent disinfection—None.
      6. Terminal disinfection—Destroy all vermin and vermin eggs on body of patient, if not already accomplished. Destroy all vermin and eggs on clothing. Rooms to be rendered free from vermin.

   (B) General measures—

      Delousing of persons, clothing, and premises during epidemics, or when they have come or have been brought into an uninfected place from an infected community.

Whooping Cough

1. *Infectious agent*: Bacillus pertussis (Bordet, Gengou).
2. *Source of infection*: Discharges from the laryngeal and bronchial mucous membranes of infected persons (sometimes also of infected dogs and cats, which are known to be susceptible).
3. *Mode of transmission*: Contact with an infected person or animal or with articles freshly soiled with the discharges of such person or animal.
4. *Incubation period*: Within 14 days.
5. *Period of communicability*: Particularly communicable in the early catarrhal stages before the characteristic whoop makes the clinical diagnosis possible. Communicability probably persists not longer than two weeks after the development of the characteristic whoop or approximately four weeks after the onset of catarrhal symptoms.
6. *Methods of control*:
   (A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms, supported by a differential leucocyte count, and confirmed where possible by bacteriological examination of bronchial secretions.
2. Isolation—Separation of the patient from susceptible children, and exclusion of the patient from school and public places, for the period of presumed infectivity.
3. Immunization—Use of prophylactic vaccination recommended by some observers. Not effective in all cases.
4. Quarantine—Limited to the exclusion of nonimmune children from school and public gatherings for 14 days after their last exposure to a recognized case.
5. Concurrent disinfection—Discharges from the nose and throat of the patient and articles soiled with such discharges.
6. Terminal disinfection—Cleaning of the premises used by the patient.

(B) General measures—

Education in habits of personal cleanliness and in the dangers of association or contact with those showing catarrhal symptoms with cough.

Yellow Fever

1. *Infectious agent.*—Unknown.
2. *Source of infection.*—The blood of infected persons.
3. *Mode of transmission.*—By the bite of infected Aedes calopus mosquitoes.
4. *Incubation period.*—Three to five days, occasionally six days.
5. *Period of communicability.*—First three days of the fever.
6. *Methods of control*:

(A) The infected individual and his environment—

1. Recognition of the disease—Clinical symptoms.
2. Isolation—Isolate from mosquitoes in a special hospital ward or thoroughly screened room. If necessary the room or ward should be freed from mosquitoes by fumigation. Isolation necessary only for the first three days of the fever.
3. Immunization—None.
4. Quarantine—Contacts for six days.
5. Concurrent disinfection—None.
6. Terminal disinfection—None. Upon termination of case the premises should be rendered free from mosquitoes by fumigation.

(B) General measures—

Eliminate mosquitoes by rendering breeding impossible.

(C) Epidemic measures—

1. Inspection service for the detection of those ill with the disease.
2. Fumigation of houses in which cases of disease have occurred, and of all adjacent houses.
3. Destruction of Aedes calopus mosquitoes by fumigation; use of larvicides; eradication of breeding places.

APPENDIX B

DISINFECTION AND DISINFECTANTS

The purpose of adding this appendix is to give a brief statement of the chemical and physiological principles involved in the action of the various disinfectants and certain facts relative to their use, which may be convenient for the reference of the dental practitioner.

Definitions.—A few definitions will be necessary as a basis for discussion.

Disinfection means the destruction of the agents causing infection.

Sterilization refers to the destruction of all forms of life in a certain medium or location.

Sepsis is a bacteriological process of decay.

Antiseptics are substances which prevent decomposition and decay. They do not necessarily destroy the organisms.

Asepsis is the absence of living organisms.

A *germicide* is a substance which has the power of destroying germs.

A *deodorant* is a substance which destroys or neutralizes the odors arising from the putrefaction or fermentation of organic substances.

Disinfection Versus Sterilization.—Most organisms which produce disease are not spore-forming and it is, therefore, possible to disinfect in most instances without complete sterilization. Material containing the bacilli of tetanus and anthrax or the bacillus of malignant edema or B. welchii requires sterilization because these bacilli form spores.

Dry heat at a temperature of 160° C. or a temperature of 150° C. maintained for one hour will kill spores. Steam under a pressure of 15 pounds per square inch will kill spores

in fifteen minutes. Steam at 15 lbs. pressure has a temperature of about 120° C.

Antiseptics.—Sugar and salt are the ordinary household antiseptics. These substances like freezing or drying prevent the development of the microorganisms which may still remain alive. Weak solutions of certain disinfectants like mercury bichloride are antiseptic substances.

Deodorants.—Dryness is the great natural deodorant. Substances which are thoroughly dried will not give off disagreeable smells. An example of this is seen in the sanitary dry privy. Dryness sufficient to deodorize, however, is not sufficent to sterilize or disinfect.

Of the chemical substances formaldehyde is an excellent deodorant as well as germicide since it combines directly with the putrefactive substances to form new substances which are not malodorants.

Fumigation.—Fumigation is a process of liberating gases or fumes for the purpose of destroying the causes of infection or possible carriers of infection. Fumigation may therefore be directed either against germs or against insects and other animals which spread disease. It is now chiefly used to kill insects and other animals. There is a wide difference between fumigation and disinfection and the two words should not be used interchangeably. The ordinary fumigants are formaldehyde gas, sulphur dioxide (SO_2), hydrocyanic acid (HCN), the halogens, carbon bisulphide (CS_2), carbon tetrachloride (CCl_4), and pyrethrum.

Disinfection.—It is important to know what to disinfect, how to disinfect, and when to disinfect in order that the work may be done efficiently and completely. Bedside and continuous disinfection is far more important than terminal fumigation in preventing the spread of disease. In controlling any communicable disease the causative organism and modes of transmission should be thoroughly understood.

Control of Disinfection.—The efficiency of a disinfecting process may be determined by saturating cotton threads with

a culture of B. prodigiosus, grown in Dunham's Peptone Medium. These threads are subjected to the process of disinfection with the other material, then planted in tubes of sterile broth where growth may be readily determined by the development of red color.

Natural Disinfection.—Nature's disinfecting agencies include (1) dilution, as exemplified by the purification of polluted water by storage, (2) sunlight, which kills organisms by its actinic rays; (3) dryness if sufficient and prolonged and (4) symbiosis, as exemplified in the destruction of disease germs in sewage by the action of the bacteria of putrefaction.

The Ideal Disinfectant has not yet been found. Such a substance would be highly germicidal, free from organic matter, reasonably stable, soluble or readily miscible in water forming a permanent emulsion; it should be harmless to man and the higher animals, possessed of a good power of penetration without bleaching fabrics or pigments and corroding metals.

Standardizing Disinfectants.—In order that we may have a terminology by which the disinfecting power of a substance may be stated there has been developed a method of standardizing disinfectants by comparing them with phenol. By this comparison the so-called *carbolic coefficient* is determined. This states the germicidal power of the given substance as compared with that of 5% carbolic acid.

The test is limited to the effect of the germicide upon naked bacterial cells under favorable conditions for action. The time is constant and the strength of the disinfectant is varied. A 24-hour culture of B. typhosus, grown in bouillon after having been transplanted for three successive days, is used as a test organism.

The steps in making the *Rideal-Walker test* for standardizing disinfectants are as follows:

(1) Make up Standard solution of 5% phenol.

(2) Prepare three test tubes using 5 c.c. of this in the fol-

lowing dilutions: 1 to 90, 1 to 100, 1 to 110. Tubes 1 inch in diameter are used.

(3) Various dilutions of the substance to be tested are made (5 c.c. being used in each test tube).

(4) All solutions as well as the cultures are brought to 20° C. on a water bath.

(5) Add 0.1 c.c. of culture to each tube at intervals of 30 sec. (Use tubes in groups of 5.)

(6) At end of 2½ minutes begin to transplant with a standard loop (4 mm. No. 14 wire U. S. Gauge) to broth culture. Transplant from each tube at the end of 2½ minute period.

(7) Make a second transplanting from each tube when it has been exposed 5 minutes.

(8) Incubate transplants 48 hours at 37° C. and read plus or minus. The carbolic coefficient is the factor obtained by dividing the highest dilution of the unknown disinfectant which permitted growth of both the 2½ and 5 minutes exposure by the highest dilution of the phenol which gave the same result.

Physical Agents of Disinfection.—The following list enumerates the physical means of disinfection with the briefest comment as to their use and efficiency.

(1) *Sunlight* is an active germicide. It destroys spores as well as bacteria. The blue-violet and ultra-violet rays possess germicidal power.

(2) *Ultra-Violet Rays* kill spores and vegetative cells.

(3) *Electricity* may kill germs either by thermal or electrolytic action but it is not adapted to general or practical use.

(4) *Burning* is best for those things which may be destroyed.

(5) *Dry heat,* 150° C. for one hour will destroy both vegetative cells and spores. Dry heat lacks penetration and is injurious to fabrics.

(6) *Boiling* is very effective, and is particularly applicable to the disinfection of bedding, body linen, towels, fabrics of many kinds, kitchen and table ware, cuspidors, etc. The

efficacy of boiling water is increased by the addition of alcohol, mercury bichloride or alkaline coal tar creosotes. Ten per cent sodium bicarbonate will prevent rusting.

(7) *Steam* is satisfactory, reliable, quick and penetrating. It sterilizes, but shrinks woolens and injures silks. It ruins leather, furs, skins of all kinds, rubber shoes, oilcloth and articles containing rubber, glue, varnish or wood.

GASEOUS DISINFECTION

Terminal fumigation was formerly practiced following almost every communicable disease but of late this practice has been largely discontinued. In most diseases the thorough airing and sunning of the room and the disinfection of all articles which have come in contact with the patient are sufficient. There has been a false sense of security in fumigation and it has too frequently been carelessly carried out while the more important disinfection of contaminated material has been neglected. Many health departments continue to fumigate after smallpox, scarlet fever and diphtheria, but even this is likely to be abandoned. If it is done it should be certain that the room is made tight by pasting paper over cracks and holes and that the gases or fumes are liberated in proper quantity and given the proper time for action, under suitable conditions of temperature and moisture. Fumigation will always be continued to kill animals which carry the germs of infectious disease. Whether rooms are fumigated or not they should always be renovated, cleaned and aired after a case of infectious disease. Continuous and terminal disinfection of contaminated material should never be neglected.

Formaldehyde Gas.—Formaldehyde is the most generally applicable gas for this type of disinfection. Neither this nor any other gas has great power of penetration and its use must be limited to surface disinfection. It is highly irritating but not poisonous to man and does not injure fabrics, colors, metals or paintings. Its specific gravity is about that of the

air and it diffuses slowly. It is not an insecticide. It combines with decomposing nitrogenous substances and deodorizes them. It *may* kill spores and dry organisms.

Formalin as it is purchased in the market is a 40 per cent solution of formaldehyde gas in water. At 20° C. the gas polymerizes and forms trioxymethylene, a white crystalline substance.

There are two methods of liberating or driving off formaldehyde gas by the heat liberated from chemical reactions.

In the *Permanganate-Formalin Method* 25 grams of $KMnO_4$ are added to 500 c.c. of formalin for every 1000 cubic feet of air space.

In the *Formalin-Lime-Aluminum-Sulphate Method* two solutions are used. Solution A contains 150 grams of aluminum sulphate dissolved in hot water (300 c.c.). Solution B contains 600 c.c. of Formalin. Solutions one and two are mixed and poured upon 2000 grams of unslaked lime. These quantities give the proper amount of gas for 1000 cubic feet of air space.

Exposure should be from six to twelve hours for disinfection with the air at a temperature of 65° F. and at least 60 per cent saturated with moisture.

Besides these methods of liberating formaldehyde gas there are other ways of disinfecting with it, viz.: (1) the autoclave under pressure, (2) the retort without pressure, (3) a generator or lamp, (4) formaldehyde and dry heat in partial vacuum, (5) spraying formalin, (6) heating paraform.

Sulphur Dioxide.—The gas SO_2 depends upon a combination with water and the formation of sulphurous acid (H_2SO_3) for its disinfecting action. Its efficiency, therefore, depends upon the moisture present in the air. It is heavier than air and readily soluble in water. It does not penetrate nor does it kill spores.

The methods of fumigating with SO_2 include: (1) The Pot Method by which sulphur is burned in a metal dish, (2) The Liquid Sulphur Dioxide Method in which liquid SO_2 pur-

chased in tubes is allowed to evaporate, (3) The Sulphur Furnace method by which the fumes are poured into the room or space to be fumigated.

Five pounds of sulphur per 1000 cubic feet of room space are required for germicidal action; 2 lbs. per 1000 cubic feet of room space are required for insecticidal action. One pound of sulphur is the equivalent of 2 lbs. of liquid SO_2.

This gas is used primarily as an *insecticide* and in such capacity needs no moisture. When so used in a house moisture should be avoided as in the presence of water it rots fabrics, injures paintings and metallic fixtures, and bleaches pigment. The reaction time ranges from 6 to 12 hours.

Oxygen in its nascent state is a good disinfectant. It kills by combining chemically with the albuminous matter of the bacterial cell.

Hydrocyanic Acid is dangerous because it is so deadly a *poison for man.* It is a good insecticide but not a good germicide. It is not toxic to plants, but is particularly toxic to animals. It does not destroy paintings, furniture, draperies or carpets. It is slightly lighter than air, invisible, and has the odor of bitter almonds.

It is evolved by the action of H_2SO_4 on KCN: ($1\frac{1}{2}$ parts H_2SO_4, and $2\frac{1}{4}$ parts H_2O, to 1 part KCN). Mix the water and acid together then add potassium cyanide. Use 4 ounces to 5 ounces of KCN per 1000 cubic feet. Sometimes SO_2 is used with HCN because the odor of the sulphur will give warning of the more deadly gas. It is most used to rid isolated buildings and ships of vermin.

LIQUID DISINFECTANTS

Disinfecting *solutions* have great powers of penetration, whereas, *emulsions* do not penetrate but have a high germicidal action on a surface where the suspended material of the emulsion accumulates.

Mercuric Chloride ($HgCl_2$) is a valuable germicide, destructive to all microbial life in weak solutions. It kills both germs and spores but does not deodorize. It is highly poisonous. It corrodes metals and forms insoluble and inert compounds with albuminous matter.

$HgCl_2$ is a white, volatile and crystalline substance, dissolving in 16 parts of cold water and 3 parts of boiling water. It is highly soluble in alcohol. HCl, NaCl, and NH_4Cl aid in its solution. It is decomposed by lead, copper and other metals. It is used in dilutions of 1:500 or 1:1000. A solution of 1:1000 kills vegetative cells in ½ hour. A 1:500 dilution kills spores in 1 hour. A 1:1000 solution = 1 gm. per liter or 1 dram per gal.

Formalin is a forty per cent solution of formaldehyde gas in water. It acts well in the presence of albuminous matter and is not injurious to most articles. It is a true deodorant and not very poisonous to man although it is unstable and polymerizes in cold weather to form trioxymethylene. Hot formalin attacks iron and steel but does not attack copper, brass, nickel, or zinc. It has no detrimental effect on fibers and does not bleach colors but it renders leather and furs brittle. A ten per cent solution of formaldehyde is equivalent to a 1 to 500 solution of $HgCl_2$ and superior to 5 per cent phenol. Feces are deodorized (and disinfected when thoroughly mixed) by 10 per cent formalin.

Potassium Permanganate ($KMnO_4$) has limited application since it is readily reduced by organic matter but it is a good germicide in surgical practice. It is a dark purple, crystalline substance and has a sweet astringent taste. Probably free nascent oxygen is the true disinfecting agent. It kills vegetative organisms and spores. It is soluble in 16 parts cold water and 2 parts boiling water.

Lime is one of the best and cheapest disinfectants we have. It is used as slaked lime or as chlorinated lime for destroying infection in organic matter. CaO is obtained by calcinating or heating native $CaCO_3$ (chalk, limestone, or marble). The

addition of water to calcinated lime produces slaked lime which may be used for germicidal purposes. *Slaked lime* [Ca $(OH)_2$] is a mixture of one pint of water for every 2 lbs. of calcinated lime. Lime absorbs about one-half its weight of water. Freshly slaked lime should be used, else CO_2 is absorbed from the air, and the slaked lime becomes inert $CaCO_3$.

Whitewash is slaked lime diluted with ten parts of water and mixed with glue. It is valuable for destroying spore free bacteria that have lodged on the surfaces of rooms, barns, stables, etc.

Milk of Lime is slaked lime diluted with about 4 times its volume of water to a thick creamy consistency. It is useful for the disinfection of excreta and privy vaults. Freshly slaked lime must be used in its preparation. If older than a few days it is probably worthless.

Ten per cent Ca $(OH)_2$ solution kills vegetative germs in a few hours; a 3 per cent Ca $(OH)_2$ solution kills typhoid in one hour; a 20 per cent Ca $(OH)_2$ solution will sterilize feces in one hour.

DISINFECTION IN DENTAL PRACTICE

Hands.—All dirt should be removed and the tissues kept in a soft condition; short nails are easier to keep clean. Scrub with soap and water using a brush, and rinse off with 70 per cent alcohol. Solutions of $HgCl_2$ are more or less injurious to the hands but are often used. A 2 per cent solution of phenol followed by the use of a deodorant to remove odor may be used.

Materials.—Instruments should be boiled and wiped off with alcohol. Boiling water is used for broaches, and broach holders, burnishers, burs, clamps, chisels, drills, excavators, explorers, hand pliers, pluggers, reamers, elevators, scissors, scalers and spatulas. Mirrors may be washed in hot water and wiped in alcohol. The glass table or instrument rest

should be washed with alcohol after each use to prevent spots of blood or mucus from getting onto instruments. Chip blower tips should be passed through the flame before using. Cotton rolls, cottonoid napkins, gauze and cotton pellets should be kept in closed glass jars. The engine hand piece may be boiled in green soap solution and should always be wiped with alcohol before using. Cotton and gauze materials may be sterilized by dry heat and kept in sealed packages.

With the development of a more widespread and popular knowledge of bacteria and communicable disease many people watch both the personal hygiene of the dentist and his care of the instruments more closely than he suspects.

The Office should be kept well aired and free from dust. Articles handled or mouthed by patients who may have an infectious disease should be burned or disinfected. Furniture handled by them may be washed in 5 per cent phenol. Napkins should be boiled. Paper cups and paper cuspidors should be used and burned.

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